

Site Health and Safety Plan

Monroe Township Contaminated Soil Site

&

Malaga Road Ash Pile Site

Date: April 8, 1994

378864



SITE HEALTH AND SAFETY PLAN

**Monroe Township Contaminated Soil Site
&
Malaga Road Ash Pile Site**

Date: April 19, 1994

Prepared For:

**US Environmental Protection Agency
Region 2**

Prepared By:

**Roy F. Weston, Inc.
Technical Assistance Team
Major Programs Division**

With the assistance of HASP


EPA Approval

4/21/94
Date


TAT Approval

4-19-94
Date


ERCS Approval

5/9/94
Date

**** Table of Contents ****

1.0	INTRODUCTION	1-1
1.1	Scope and Applicability of the Site Health and Safety Plan	1-1
1.2	Visitors	1-1
2.0	KEY PERSONNEL/IDENTIFICATION OF HEALTH AND SAFETY	2-1
2.1	Key Personnel	2-1
2.2	Site Specific Health and Safety Personnel	2-1
2.3	Organizational Responsibility	2-2
3.0	TASK/OPERATION SAFETY AND HEALTH RISK ANALYSIS	3-1
3.1	Historical Overview of Site	3-1
3.1.1	Malaga Road Ash Pile Site	3-1
3.1.2	Monroe Township Contaminated Soil Site	3-2
3.2	Task by Task Risk Analysis	3-3
3.2.1	Task Hazard Descriptions	3-3
3.3	Chemical Hazards	3-10
4.0	PERSONNEL TRAINING REQUIREMENTS	4-1
4.1	Preassignment and Annual Refresher Training	4-1
4.2	Site Supervisors Training	4-1
4.3	Training and Briefing Topics	4-1
5.0	PERSONAL PROTECTIVE EQUIPMENT TO BE USED	5-1
5.1	Levels of Protection	5-1
5.2	Level A Personnel Protective Equipment	5-2
5.3	Level B Personnel Protective Equipment	5-2
5.4	Level C Personnel Protective Equipment	5-3

5.5	Level D Personnel Protective Equipment	5-4
5.6	Reassessment of Protection Program	5-4
5.7	Work Mission Duration	5-4
5.8	Chemical Resistance and Integrity of Protective Material	5-5
5.9	SOP for Respiratory Protection Devices	5-5
5.9.1	Cleaning and Disinfecting Air Purifying Respirators	5-5
5.9.1.1	Daily Cleaning Procedure	5-5
5.9.1.2	After Routine Use in Exclusion Zone	5-6
5.9.2	APR Inspection and Checkout	5-7
5.9.3	Storage of Air Purifying Respirators	5-7
5.10	SOP for Personal Protective Clothing	5-8
5.10.1	Inspection	5-8
5.11	Specific Levels of Protection Planned for the Site	5-10
6.0	MEDICAL SURVEILLANCE REQUIREMENTS	6-1
6.1	Baseline or Preassignment Monitoring	6-1
6.2	Periodic Monitoring	6-1
6.3	Site Specific Medical Monitoring	6-2
6.4	Exposure/Injury/Medical Support	6-2
6.5	Exit Physical	6-2
7.0	FREQUENCY AND TYPES OF AIR MONITORING/SAMPLING	7-1
7.1	Direct-Reading Monitoring Instruments	7-1
7.2	Air Sampling	7-5
7.3	Specific Contaminants to be monitored at the Site	7-5
7.4	Site Monitoring and Sampling Program	7-6
8.0	SITE CONTROL MEASURES	8-1

8.1	Buddy System	8-1
8.2	Site Communications Plan	8-1
8.3	Work Zone Definition	8-1
8.4	Nearest Medical Assistance	8-2
8.5	Safe Work Practices	8-2
8.6	Emergency Alarm Procedures	8-2
9.0	DECONTAMINATION PLAN	9-1
9.1	Standard Operating Procedures	9-1
9.2	Levels of Decontamination Protection Required for Personnel	9-1
9.3	Equipment Decontamination	9-1
9.4	Disposition of Decontamination Wastes	9-1
10.0	EMERGENCY RESPONSE/CONTINGENCY PLAN	10-1
10.1	Pre-Emergency Planning	10-1
10.2	Personnel Roles and Lines of Authority	10-1
10.3	Emergency Recognition/Prevention	10-1
10.4	Evacuation Routes/Procedures	10-2
10.5	Emergency Contact/Notification System	10-4
10.6	Emergency Medical Treatment Procedures	10-6
10.7	Fire or Explosion	10-6
10.8	Spill or Leaks	10-6
10.9	Emergency Equipment/Facilities	10-6
11.0	SPILL CONTAINMENT PROGRAM	11-1
12.0	HAZARD COMMUNICATION	12-1

ATTACHMENTS

- Attachment A Material Safety Data Sheets**
- Attachment B 29 CFR 1910.1018 OSHA Inorganic Arsenic Standard
Appendix A to 29 CFR 1910.1018 Substance Information Sheet**
- Attachment C Appendix A to 29 CFR 1910.1025
Substance Data Sheet for Occupational Exposure to Lead
Appendix B to 29 CFR 1910.1025
Employee Standard Summary**
- Attachment D Safety Plan Review and Acknowledgement Form**
- Attachment E OHM Health and Safety Plan Amendments**

1.0 INTRODUCTION

This section of the Site Health and Safety Plan (HASP) document defines general applicability and general responsibilities with respect to compliance with Health and Safety programs.

1.1 Scope and Applicability of the Site Health and Safety Plan

The purpose of this Site Health and Safety Plan is to define the requirements and designate protocols to be followed at the Site during investigation and remediation activities. Applicability extends to all Government employees, contractors, subcontractors, and visitors.

All personnel on site, contractors and subcontractors included, shall be informed of the site emergency response procedures and any potential fire, explosion, health, or safety hazards of the operation. This HASP summarizes those hazards in table 3.1 and defines protective measures planned for the site.

This plan must be reviewed and an agreement to comply with the requirements must be signed by all personnel prior to entering the exclusion zone or contamination reduction zone.

During development of this plan consideration was given to current safety standards as defined by EPA/OSHA/NIOSH, health effects and standards for known contaminants, and procedures designed to account for the potential for exposure to unknown substances. Specifically, the following reference sources have been consulted:

- o OSHA 29 CFR 1910.120 and EPA 40 CFR 311
- o U.S. EPA, OERR ERT Standard Operating Safety Guides
- o NIOSH/OSHA/USCG/EPA Occ. Health and Safety Guidelines
- o (ACGIH) Threshold Limit Values

1.2 Visitors

All visitors entering the contamination reduction zone and exclusion zone at the Site will be required to read and verify compliance with the provisions of this HASP. In addition, visitors will be expected to comply with relevant OSHA requirements such as medical monitoring (Sec. 6.0), training (Sec. 4.0), and respiratory protection (if applicable). Visitors will also be expected to provide their own protective equipment.

In the event that a visitor does not adhere to the provisions of the HASP, he/she will be requested to leave the work area. All nonconformance incidents will be recorded in the site log.

2.0 KEY PERSONNEL/IDENTIFICATION OF HEALTH AND SAFETY

2.1 Key Personnel

The following personnel and organizations are critical to the planned activities at the Site. The organizational structure will be reviewed and updated periodically by the site supervisor.

EPA Representatives

James D. Harkay

TAT Representatives

Eric Wilson
Bartt Booz

ERCS Representatives

2.2 Site Specific Health and Safety Personnel

The Site Health and Safety Officer (HSO) has total responsibility for ensuring that the provisions of this HASP are adequate and implemented in the field. Changing field conditions may require decisions to be made concerning adequate protection programs. Therefore, it is vital that personnel assigned as HSO be experienced and meet the additional training requirements specified by OSHA in 29 CFR 1910.120 (see Section 4.0 of this HASP). The HSO is also responsible for conducting site inspections on a regular basis in order to ensure the effectiveness of this plan.

The HSO at the site is James D. Harkay

Designated alternates include:

- Eric Wilson
- Bartt Booz
- Other qualified TAT members

2.3 Organizational Responsibility

U.S. Environmental Protection Agency (EPA): In the capacity as On-scene Coordinator (OSC), the EPA representative is responsible for overall project administration and contractor oversight. As a part of that oversight function, EPA will ensure that project plans meet OSHA requirements at a minimum, and that the Health and Safety of all site personnel is a primary concern. As an OSC, EPA serves in the capacity of site supervisor.

Technical Assistance Team (TAT): The Technical Assistance Team (TAT) is responsible for providing the OSC with assistance and support in regards to all technical, regulatory, and safety aspects of site activity. The TAT is also available to advise the OSC on matters relating to sampling, treatment, packaging, labeling, transport, and disposal of hazardous materials.

Emergency Response Cleanup Service (ERCS): The ERCS contractor has primary responsibility for supplying personnel and equipment for emergency removal operations under an OSC's oversight. The response manager for ERCS has overall responsibility for ensuring that safety aspects of the removal project are implemented and technical progress is constant.

3.0 TASK/OPERATION SAFETY AND HEALTH RISK ANALYSIS

3.1 Historical Overview of Sites

This HASP defines the hazards and methods to protect personnel from those hazards as identified in previous site work or background information. For a thorough overview of historical information concerning the Site see the following documents:

Action Memoranda

James D. Harkay
US EPA

February 18, 1994 and January 28, 1994

The Malaga Road Ash Pile Site and the Monroe Township Contaminated Soil Site are located approximately 1000 feet from one another and contain almost identical hazards and contaminants. Removal actions at the site will be conducted simultaneously. This HASP specifies health and safety protocols to be followed for remediation activities for both the Malaga Road Ash Pile Site and the Monroe Township Contaminated Soil Site. The details for the two site are the following:

3.1.1 Malaga Road Ash Pile Site

On June 7, 1993, the Emergency Management Coordinator for Monroe Township notified EPA of the existence of an ash pile in a wooded section of the township. The site was formally referred to EPA for Removal Action consideration by the New Jersey Department of Environmental Protection and Energy on October 5, 1993. Between October 4 and 7, 1993 the EPA Technical Assistance Team (TAT) conducted an assessment of the site. The extent of metals contamination was delineated using an X-Ray Fluorescence Analyzer (XRF). In addition, a composite sample of the waste was collected and analyzed in order to identify the presence of hazardous substances and characterize the waste for disposal. The results of the screening and analysis identified high concentrations of antimony, arsenic, barium, cadmium, copper, lead, mercury, nickel, silver, thallium, zinc and low concentrations of dioxins.

The site is located in a residential area, approximately 1,250 feet from Malaga & New Brooklyn Road. The burn area is within the boundaries of the property listed as Block 4301, Lot 2 on the tax map of Monroe Township, Gloucester County, New Jersey.

The burn area measures approximately 70 feet long by 50 feet wide. An irregularly shaped ash mound measuring 50 feet by 30 feet is located within the burn area. The area affected by migration of contaminants from the burn

area is estimated to encompass 8,900 square feet. The site exhibits similar physical and chemical characteristics to the Franklin Burn Sites; therefore it is believed that the site was also used for burning insulated electrical wires to recover and sell copper. The site is unsecured. Evidence indicates that the area is used for recreation. All-terrain vehicle (ATV) tracks and hunters have been observed on the access road to the site.

3.1.2 Monroe Township Contaminated Soil Site

On June 7, 1993, the Emergency Management Coordinator for Monroe Township notified EPA of the existence of an ash pile in a wooded section of the township. The site was formally referred to EPA for Removal Action consideration by the New Jersey Department of Environmental Protection and Energy on October 5, 1993. Between October 4 and 7, 1993 the EPA Technical Assistance Team (TAT) conducted an assessment of the site. The extent of metals contamination was delineated using an X-Ray Fluorescence Analyzer (XRF). In addition, composite samples of the waste were collected and analyzed in order to identify the presence of hazardous substances and characterize the waste for disposal. The results of the screening and analysis identified high concentrations of antimony, arsenic, barium, cadmium, copper, lead, mercury, silver, thallium, zinc and low concentrations of dioxins.

The site is located in a residential area, approximately 2,100 feet from Malaga & New Brooklyn Road. The burn area is located at the intersection of three privately owned properties identified as Block 4001 Lot 1, Block 4001 Lot 27, and Block 4301, Lot 20 on the tax maps of Monroe Township, Gloucester County, New Jersey.

The burn area is irregular in shape and measures approximately 150 feet long by 110 feet wide, and contains two ash piles. Ash has migrated to the south along a drainage pathway towards the Squankum Branch, a tributary of the Great Egg Harbor River. Contaminants have also been detected along the access road to the ash pile, this contamination is attributed to anthropogenic redistribution. The contaminated area, including associated areas affected by migration of contaminants from the burn area is estimated to encompass 20,000 square feet.

The site exhibits similar physical and chemical characteristics to the Franklin Burn Sites; therefore it is believed that the site was also used for burning insulated electrical wires to recover and sell copper. The site is unsecured. Evidence indicates that the area is used for recreation. All-terrain vehicle (ATV) tracks have been observed on the access road to the site and hunters have been observed crossing the burn area.

3.2 Task by Task Risk Analysis

The evaluation of hazards is based upon the knowledge of site background presented in Section 3.1, and anticipated risks posed by the specific operation.

The following subsections describe each task/operation in terms of the specific hazards associated with it.

3.2.1 Task Hazard Descriptions

Mobilization/Site Setup:

General hazards encountered during mobilization/site setup include the following:

- o Back strain from clearing vegetation with a scythe or other cutting tool.
- o Driving vehicles, placing trailers, and collecting rubbish, on uneven surfaces creates a possibility of the vehicle rolling, getting stuck in mud or ditches, or of an accident due to flat tires or striking obstacles, and the vehicles.
- o Exposure to irritant and toxic plants such as poison ivy and sticker bushes may cause allergic reactions to personnel.
- o Surfaces covered with heavy vegetation; undergrowth create a tripping hazard.
- o Native wildlife such as rodents, ticks, and snakes present the possibility of insect bites and associated diseases such as Lyme disease.
- o The hazard of being struck by heavy equipment can exist when working in close proximity to heavy equipment.

HAZARD PREVENTION

- o Back strain can be prevented by frequent breaks in routine. Use slow, even, movements and proper lifting techniques (i.e., with the legs). Work gloves will reduce the incidence of hand injury and blisters associated with hand scything.
- o Proper vehicle maintenance will prevent avoidable vehicle breakdown in the field. In order to minimize accidents from uneven terrain, a site surveillance should be performed on foot to choose a clear driving path.
- o Seat belts should be worn at all times.

- o Wear long sleeved clothing and slacks to minimize contact with irritant and toxic plants and to protect against insect bites. Appropriate first aid for personnels' known allergic reactions.
- o Be alert and observe terrain while walking to minimize slips and falls. Steel-toed boots provide additional support and stability.
- o Avoid wildlife when possible. In case of an animal bite, perform first aid and capture the animal, if possible, for rabies testing. Perform a tick check after leaving a wooded or vegetated area.
- o At a minimum, all heavy equipment shall have the safety features outlined in OSHA 29 CFR 1910/1926 Subpart O.
- o Heavy equipment operators should have proper training and experience.
- o Personnel approaching operating heavy equipment should stay outside the range of the equipment until they have been acknowledged by the operator.

Clearing/grading:

In addition to the general hazards associated with mobilization/site setup the specific hazards associated with clearing/grading include the following:

- o Back strain from clearing vegetation for road with a scythe or other cutting tool.

HAZARD PREVENTION

- o Use slow, even, movements and proper lifting techniques (i.e., with the legs). Work gloves will reduce the incidence of hand injury and blisters associated with hand scything.

Road construction:

In addition to the general hazards associated with mobilization/site setup the specific hazards associated with road construction include the following:

- o Irritation from dust generated from road construction.

HAZARD PREVENTION

- o Dust suppression techniques, i.e., wetting the soil with water, will reduce dust exposure.

Trailer placement:

In addition to the general hazards associated with mobilization/site setup the specific hazards associated with trailer placement include the following:

- o Crushing or pinching hazard due to trailer placement.

HAZARD PREVENTION

- o All personnel should stay clear of trailers during placement.

Utility hook-up:

In addition to the general hazards associated with mobilization/site setup the specific hazards associated with utility hook-up include the following:

- o Several types of hazards can be associated with utility hook-up depending on the particular work activity. Construction of temporary poles for electrical and/or telephone lines can disturb potentially contaminated soils. The hazard of electrocution exists when working around or with live electrical wires.

HAZARD PREVENTION

- o Hazards associated with the particular utility would be anticipated and proper measures should be undertaken by the subcontractor employer. General provisions of 29 CFR 1910/1926 Subpart K, should be implemented in order to prevent electrical hazards.

Debris collection/disposal:

In addition to the general hazards associated with mobilization/site setup the specific hazards associated with rubble collection include the following:

- o Back strain from lifting debris
- o Cuts and lacerations from sharp or ragged edges.

HAZARD PREVENTION

- o Back strain can be prevented by frequent breaks in routine. Use slow, even, movements and proper lifting techniques (i.e., with the legs).
- o Work gloves will reduce the incidence of hand injury.

Perimeter monitoring:

These site boundaries clearly mark off the "clean" off-site areas, from the "contaminated" on-site areas, and so chemical contamination from the site should not be a hazard associated with perimeter and off-site monitoring. Perimeter monitoring and off-site monitoring are performed once the site boundaries have been established. Hazards specific to perimeter and off-site monitoring include encounters with residents and non-project personnel. Inquisitive and/or hostile persons may interfere with the monitoring/sampling effort, jeopardizing the safety of themselves as well as the safety of the field team.

HAZARD PREVENTION

To minimize public involvement in perimeter monitoring/off-site monitoring, the most effective preventative measure is to inform all interested parties. Notifying state and local police, the fire department, and any local/state governmental officials of the projects purpose and scope will allow those authorities to answer questions posed to them by local residents and the media by preparing statements on the projects purpose or by informing the public where to call for further information. This will alleviate the problem of work stoppage due to field personnel answering questions.

Air sampling/monitoring:

General hazards frequently encountered during air sampling and monitoring include:

- o Electrical hazards as a result of power sources to run sampling pumps.
- o Placing sampling pumps in elevated areas or areas where slip/trip and fall hazards exist.
- o Hazards associated with ambient environment being sampled.
- o Readings indicating nonexplosive atmospheres, low concentrations of toxic substances, or other conditions may increase or decrease suddenly, changing the associated risks.
- o Air sampling matrix solutions may be acidic or basic, causing a corrosive hazard, and broken glass collection tubes can cut hands if mishandled.

HAZARD PREVENTION

- o Grounded plugs should be used when a power source is needed to reduce the hazard of electric shock.

- o Generators or air pumps should be used in dry areas, away from possible ignition sources. Do not stand in water or other liquids when handling equipment. Electrical equipment shall conform with OSHA 1910.303(a), 1910.305(a),(f),(f)(3).
- o Ground fault interrupters are used in the absence of properly grounded circuitry or when portable tools must be used in wet areas.
- o Extension cords should be protected from damage and maintained in good condition.
- o Air pumps should be placed within easy reach using a ladder, elevated platform or by placing the pump on a stake.
- o Personnel should be thoroughly familiar with the use, limitations and operating characteristics of the monitoring instruments.
- o Perform continuous monitoring in variable atmospheres.
- o Use intrinsically safe instruments until the absence of combustible gases or vapors is anticipated.
- o Proper protective clothing such as gloves and goggles should be used when handling corrosive substances. 15-minute eyewash and first aid should be available. Handle and store corrosives in appropriate areas.

Surface/Subsurface soil sampling:

For the purposes of this hazard identification section, surface soil sampling will be considered any soil sampling completed by hand using a trowel, split spoon, shovel, auger, or other type of hand-held tool. Hazards generally associated with soil and tailings/spoils sampling include:

- o Contact with or inhalation of contaminants, potentially in high concentrations in sampling media.
- o Back strain and muscle fatigue due to lifting, shoveling and auguring techniques.
- o Contact with or inhalation of decontamination solutions.

HAZARD PREVENTION

- o To minimize exposure to chemical contaminants, a thorough review of suspected contaminants should be completed and implementation of an adequate protection program.

- o Proper lifting (pre-lift weight assessment, use of legs, multiple personnel) techniques will prevent back strain. Use slow easy motions when shoveling, auguring, and digging to decrease muscle strain.
- o Material Safety Data Sheets for all decon solutions should be included with each Site Health and Safety Plan.
- o First aid equipment should be available based on MSDS requirements.

Soil excavations and load-out:

Hazards encountered during soil and test pit excavation include both chemical and physical agents, and are as follows:

- o Exposure to airborne contaminants released during intrusive activities. Flammable atmospheres encountered in excavation.
- o Sides of excavation can cave in. Possible burying or crushing of workers due to 1) absence of shoring, 2) misjudgment of stability, 3) defective shoring, and/or 4) undercut sides.
- o Falling during access/egress or while monitoring or dismounting equipment, or stumbling into excavation.
- o An overhead hazard can result from material, tools, rock, and/or soil falling into the excavation.
- o The hazard of being struck by heavy equipment can exist when working in close proximity to heavy equipment.
- o A hazard can result from operating heavy equipment in the vicinity of overhead power lines.
- o A hazard can result from excavating in the vicinity of buried utilities.

HAZARD PREVENTION

- o Monitor for airborne contaminants. Allow test pits to purge and/or use personal protective equipment. Incorporate dust suppression techniques into operating procedures when particulate contaminants are of concern.
- o Provide adequate shoring or sloping of sides of the excavation. Regularly inspect trenches for changing conditions.
- o Provide ramps or ladders to trenches to allow safe access and egress.

- o Provide an adequate barrier around open pits. Material from pit must be placed away from edge to prevent cave ins and instability of pit.
- o At a minimum, all heavy equipment shall have the safety features outlined in OSHA 29 CFR 1910/1926 Subpart O.
- o Heavy equipment operators should have proper training and experience, and documentation of both. The general provisions of 1910/1926 would apply.
- o Personnel approaching operating heavy equipment should stay outside the range of the equipment until they have been acknowledged by the operator.
- o When working near overhead power lines equipment should be kept away from electric lines regardless of their voltage.
- o Prior to initiating excavation a utility survey should be conducted and any buried utilities should be marked.

3.3 Chemical Hazards

Table 3.1 provides a summary of chemical hazards associated with the sites. Material Safety Data Sheets for all contaminants of concern are included as Attachment A. Work operations which present the potential for exposure of workers to arsenic or lead are subject to OSHA standards 29 CFR 1910.1018 and 29 CFR 1910.1025, respectively. In accordance with the OSHA Arsenic Standard, Appendix A to 29 CFR 1910.1018-Inorganic Arsenic Substance Data Sheet is included as Attachment B of this plan. In accordance with the OSHA Lead Standard, Appendix A to 29 CFR 1910.1025-Substance Data Sheet for Occupational Exposure to Lead and Appendix B to 29 CFR 1910.1025-Employee Standard Summary are provided as Attachment C of this plan.

TABLE 3.1 - TASK ANALYSIS - CHEMICAL HAZARDS OF CONCERN

CONTAMINANT	TLV ^{1,2} /IDLH (mg/m ³)	Source Conc.(mg/kg)	Routes of Exposure ³
Antimony	0.50/80	900	Con Ing Inh
Arsenic	0.01/100	300	Abs Con Ing Inh
Barium	0.50/1100	1,700	Con Ing Inh
Cadmium	0.20/50	100	Ing Inh
Chromium	1.0/NE	600	Ing Inh
Copper	1.0/NE	69,000	Con Ing Inh
Lead	0.05/700	20,000	Con Ing Inh
Mercury	0.05/28	200	Abs Con Ing Inh
Nickel	0.015/NE	600	Con Ing Inh
Selenium	0.20/100	20	Abs Con Ing Inh
Silver	0.01/NE	200	Con Ing Inh
Thallium	0.1/20	30	Abs Con Ing Inh
Zinc	NE/NE	20,000	Ing Inh
Dioxin	NE/NE	35 ug/kg	Ing Inh

- 1 - Most conservative value of OSHA PEL, ACGIH TLV and NIOSH REL is used.
- 2 - NE - Non Established
- 3 - Abs - Skin absorption, Con - Skin and/or eye contact, Ing - Ingestion
Inh - Inhalation

4.0 PERSONNEL TRAINING REQUIREMENTS

Consistent with OSHA's 29 CFR 1910.120 regulation covering Hazardous Waste Operations and Emergency Response, all site personnel are required to be trained in accordance with the standard. At a minimum all personnel are required to be trained to recognize the hazards on-site, the provisions of this HASP, and the responsible personnel.

4.1 Preassignment and Annual Refresher Training

Prior to arrival on site, each employer will be responsible for certifying that his/her employees meet the requirements of preassignment training, consistent with OSHA 29 CFR 1910.120 paragraph (e)(3). The employer should be able to provide a document certifying that each general site worker has received 40 hours of instruction off the site, and 24 hours of training for any workers who are on site only occasionally for a specific task. If an individual employee has work experience and/or training that is equivalent to that provided in the initial training, an employer may waive the 40-hour training so long as that equivalent experience is documented or certified. All personnel must also receive 8 hours of refresher training annually.

4.2 Site Supervisors Training

Consistent with OSHA 29 CFR 1910.120 paragraph (e)(8), individuals designated as site supervisors require an additional 8 hours of training.

The following individuals are identified as site supervisors:

Name	Title/Responsibility
James D. Harkay	EPA/OSC
Eric Wilson	TAT/PM

4.3 Training and Briefing Topics

The following items will be discussed by a qualified individual at the site pre-entry briefing(s) or periodic site briefings.

Training

- Air Monitoring, Sec. 7.0; [29 CFR 1910.120(h)]
- Heavy Equipment
- Chemical hazards, Table 3.1
- Engineering controls and work practices
- Medical surveillance requirements
- Personnel protective equipment, Sec. 5.0

- Physical hazards, Table 3.2
- Respiratory protection, Sec. 5.8
- Sanitation, [29 CFR 1910.120(n)]
- Site Control, Sec. 8.0; [29 CFR 1910.120(d)]
- Site characterization and analysis, Sec. 3.0
- Symptoms of overexposure to hazards
- Training requirements, Sec. 4.0; [29 CFR 1910.120(e)]

5.0 PERSONAL PROTECTIVE EQUIPMENT TO BE USED

This section describes the general requirements of the EPA designated Levels of Protection (A-D), and the specific levels of protection required for each task at the Site.

5.1 Levels of Protection

Personnel wear protective equipment when response activities involve known or suspected atmospheric contamination, vapors, gases, or particulates may be generated by site activities, or when direct contact with skin-affecting substances may occur. Full facepiece respirators protect lungs, gastrointestinal tract, and eyes against airborne toxicants. Chemical-resistant clothing protects the skin from contact with skin-destructive and absorbable chemicals.

The specific levels of protection and necessary components for each have been divided into four categories according to the degrees of protection afforded:

- Level A: Should be worn when the highest level of respiratory, skin, and eye protection is needed.
- Level B: Should be worn when the highest level of respiratory protection is needed, but a lesser level of skin protection. Level B is the primary level of choice when encountering unknown environments.
- Level C: Should be worn when the criteria for using air-purifying respirators are met, and a lesser level of skin protection is needed.
- Level D: Should be worn only as a work uniform and not in any area with respiratory or skin hazards. It provides minimal protection against chemical hazards.

Modifications of these levels are permitted, and routinely employed during site work activities to maximize efficiency. For example, Level C respiratory protection and Level D skin protection may be required for a given task. Likewise the type of chemical protective ensemble (i.e., material, format) will depend upon contaminants and degrees of contact.

The Level of Protection selected is based upon the following:

- o Type and measured concentration of the chemical substance in the ambient atmosphere and its toxicity.

- o Potential for exposure to substances in air, liquids, or other direct contact with material due to work being done.
- o Knowledge of chemicals on-site along with properties such as toxicity, route of exposure, and contaminant matrix.

In situations where the type of chemical, concentration, and possibilities of contact are not known, the appropriate Level of Protection must be selected based on professional experience and judgment until the hazards can be better identified.

5.2 Level A Personnel Protective Equipment:

- o Supplied-air respirator approved by the Mine Safety and Health Administration (MSHA) and National Institute for Occupational Safety and Health (NIOSH). Respirators may be positive pressure-demand, self-contained breathing apparatus (SCBA), or positive pressure-demand, airline respirator (with escape bottle for Immediately Dangerous to Life and Health (IDLH) or potential for IDLH atmosphere)
- o Fully encapsulating chemical-resistant suit
- o Coveralls
- o Long cotton underwear
- o Gloves (inner)
- o Boots, chemical-resistant, steel toe and shank (depending on suit construction, worn over or under suit boot)
- o Hard hat (under suit)
- o Disposable gloves and boot covers (worn over fully encapsulating suit)
- o Cooling unit
- o 2-way radio communications (intrinsically safe)

5.3 Level B Personnel Protective Equipment:

- o Supplied-air respirator (MSHA/NIOSH approved). Respirators may be positive pressure-demand, self-contained breathing apparatus (SCBA), or positive pressure-demand, airline respirator (with escape bottle for IDLH or potential for IDLH atmosphere)

- o Chemical-resistant clothing (overalls and long-sleeved jacket; hooded, one or two-piece chemical-splash suit; disposable chemical-resistant, one-piece suits)
- o Long cotton underwear
- o Coveralls
- o Gloves (outer), chemical-resistant
- o Gloves (inner), chemical-resistant
- o Boots (outer), chemical-resistant, steel toe and shank
- o Boot covers (outer), chemical-resistant (disposable)
- o Hard hat (face shield)
- o 2-way radio communications (intrinsically safe)

5.4 Level C Personnel Protective Equipment:

- o Air-purifying respirator, full-face, cartridge-equipped (MSHA/NIOSH approved)
- o Chemical-resistant clothing (coveralls; hooded, one-piece or two-piece chemical splash suit; chemical-resistant hood and apron; disposable chemical-resistant coveralls)
- o Coveralls
- o Long cotton underwear
- o Gloves (outer), chemical-resistant
- o Gloves (inner), chemical-resistant
- o Boots (outer), chemical-resistant, steel toe and shank
- o Boot covers (outer), chemical-resistant (disposable)
- o Hard hat (face shield)
- o Escape mask
- o 2-way radio communications (intrinsically safe)

5.5 Level D Personnel Protective Equipment:

- o Coveralls**
- o Gloves**
- o Boots/shoes, leather or chemical-resistant, steel toe and shank**
- o Safety glasses**
- o Hard hat**

5.6 Reassessment of Protection Program

The Level of Protection provided by PPE selection shall be upgraded or downgraded based upon a change in site conditions or findings of investigations.

When a significant change occurs, the hazards should be reassessed. Some indicators of the need for reassessment are:

- o Commencement of a new work phase, such as the start of drum sampling or work that begins on a different portion of the site.**
- o Change in job tasks during a work phase.**
- o Change of season/weather.**
- o When temperature extremes or individual medical considerations limit the effectiveness of PPE.**
- o Contaminants other than those previously identified are encountered.**
- o Change in ambient levels of contaminants.**
- o Change in work scope which effects the degree of contact with contaminants.**

5.7 Work Mission Duration

Before the workers actually begin work in their PPE ensembles the anticipated duration of the work mission should be established. Several factors limit mission length, including:

- o Air supply consumption (SCBA use).**
- o Suit/Ensemble permeation and penetration rates for chemicals (section 5.8).**

- o Ambient temperature and weather conditions (heat stress cold stress).
- o Capacity of personnel to work in PPE.

5.8 Chemical Resistance and Integrity of Protective Material

The following specific clothing materials are recommended for the site:

Soil excavations, soil load-out, soil sampling and all other activities taking place within the exclusion zone - (Level C)

Inner Gloves - Surgical

Boots/Boot Covers - Latex

Outer Gloves - Work Gloves

Outer Garment/Coveralls - Tyvek

Full-face Air Purifying Respirator

5.9 SOP for Respiratory Protection Devices

The following subsections define standard operating procedures for air purifying respirators and self-contained breathing apparatus.

5.9.1 Cleaning and Disinfecting Air Purifying Respirators

APRs in routine use should be cleaned and disinfected at least daily. Where respirators are used only occasionally or when they are in storage, the cleaning interval is weekly or monthly, as appropriate.

5.9.1.1 Daily Cleaning Procedure

The steps to be followed for cleaning and disinfecting daily are as follows:

- o Respirator Disassembly. Respirators are taken to a clean location where the filters, cartridges or canisters are removed, damaged to prevent accidental reuse, and discarded. For thorough cleaning, the inhalation and exhalation valves, speaking diaphragm, and any hoses are removed.

- o **Cleaning.** In most instances, the cleaning and disinfecting solution provided by the manufacturer is used, and is dissolved in warm water in an appropriate tub. Using gloves, the respirator is placed in the tub and swirled for a few moments. A soft brush may be used to facilitate cleaning.
- o **Rinsing.** The cleaned and disinfected respirators are rinsed thoroughly in water to remove all traces of detergent and disinfectant. This is very important for preventing dermatitis.
- o **Drying.** The respirators may be allowed to dry in room air on a clean surface. They may also be hung upside down like drying clothes, but care must be taken not to damage or distort the facepieces.
- o **Reassembly and Inspection.** The clean, dry respirator facepieces should be reassembled and inspected in an area separate from the disassembly area to avoid contamination. Special emphasis should be given to inspecting the respirators for detergent or soap residue left by inadequate rinsing. This appears most often under the seat of the exhalation valve, and can cause valve leakage or sticking.

5.9.1.2 After Routine Use in Exclusion Zone

The steps to be followed for cleaning and disinfecting in the field are as follows:

- o The mask may be washed/rinsed with soap and water.
- o At a minimum, the mask should be wiped with disinfectant wipes (benzoalkaloid or isopropyl alcohol), and allowed to air dry in a clean area.

5.9.2 APR Inspection and Checkout

1. Visually inspect the entire unit for any obvious damages, defects, or deteriorated rubber.
2. Make sure that the facepiece harness is not damaged. The serrated portion of the harness can fragment which will prevent proper face seal adjustment.
3. Inspect lens for damage and proper seal in facepiece.
4. Exhalation Valve - pull off plastic cover and check valve for debris or for tears in the neoprene valve (which could cause leakage).
5. Inhalation Valves (two) - screw off cartridges/canisters and visually inspect neoprene valves for tears. Make sure that the inhalation valves and cartridge receptacle gaskets are in place.
6. Make sure a protective cover lens is attached to the lens.
7. Make sure the speaking diaphragm retainer ring is hand tight.
8. Make sure that you have the correct cartridge.
9. Don and perform negative pressure test.

5.9.3 Storage of Air Purifying Respirators

OSHA requires that respirators be stored to protect against:

- Dust
- Sunlight
- Heat
- Extreme cold
- Excessive moisture
- Damaging chemicals
- Mechanical damage

Storage of respirators should be in a clean area which minimizes the chance for contamination or unsanitary conditions.

5.10 SOP for Personal Protective Clothing

5.10.1 Inspection

Proper inspection of PPE features several sequences of inspection depending upon specific articles of PPE and it's frequency of use. The different levels of inspection are as follows:

- o Inspection and operational testing of equipment received from the factory or distributor.**
- o Inspection of equipment as it is issued to workers.**
- o Inspection after use or training and prior to maintenance.**
- o Periodic inspection of stored equipment.**
- o Periodic inspection when a question arises concerning the appropriateness of the selected equipment, or when problems with similar equipment arise.**

The primary inspection of PPE in use for activities at the Site will occur prior to immediate use and will be conducted by the user. This ensures that the specific device or article has been checked-out by the user that the user is familiar with its use.

Table 5.1 Sample PPE Inspection Checklists

CLOTHING

Before use:

- Determine that the clothing material is correct for the specified task at hand.
- Visually inspect for:
 - imperfect seams
 - non-uniform coatings
 - tears
 - malfunctioning closures
- Hold up to light and check for pinholes.
- Flex product:
 - observe for cracks
 - observe for other signs of shelf deterioration
- If the product has been used previously, inspect inside and out for signs of chemical attack:
 - discoloration
 - swelling
 - stiffness

During the work task

- Evidence of chemical attack such as discoloration, swelling, stiffening, and softening. Keep in mind, however, that chemical permeation can occur without any visible effects.
- Closure failure.
- Tears.
- Punctures.
- Seam Discontinuities.

GLOVES

Before use:

- Visually inspect for:
 - imperfect seams
 - tears
 - non-uniform coating
 - pressurize glove with air; listen for pin-hole leaks.

The following levels of protection will be utilized during activities at the Site:

- Table 5.2 presents the level of protection planned for the completion of individual task assignments and the specific components of each protective ensemble.

TABLE 5.2

**SPECIFIC LEVELS OF PROTECTION PLANNED FOR THE
TASK ASSIGNMENTS AT THE SITE**

LEVEL C Tasks

- Soil Excavation and Load-out
- On-site Air Monitoring
- Soil Sampling
- All activities within the exclusion zone

LEVEL D Tasks

- Site Setup
- Road Construction
- Trailer Placement
- Utility Hook-up
- Off-site XRF Operations
- Perimeter Air Sampling
- Site Restoration

6.0 MEDICAL SURVEILLANCE REQUIREMENTS

Medical monitoring programs are designed to track the physical condition of employees on a regular basis as well as survey preemployment or baseline conditions prior to potential exposures. The medical surveillance program is a part of each employers Health and Safety program.

6.1 Baseline or Preassignment Monitoring

Prior to being assigned to a hazardous or a potentially hazardous activity involving exposure to toxic materials, employees must receive a preassignment or baseline physical. The contents of the physical is to be determined by the employers medical consultant. As suggested by NIOSH/OSHA/USCG/EPA's Occupational Safety & Health Guidance Manual for Hazardous Waste Site Activities, the minimum medical monitoring requirements for work at the Site is as follows:

- Complete medical and work histories.
- Physical examination.
- Pulmonary function tests (FVC and FEV1).
- Chest X-ray (every 2 years).
- EKG.
- Eye examination and visual acuity.
- Audiometry.
- Urinalysis.
- Blood chemistry and heavy metals toxicology.

The preassignment physical should categorize employees as fit-for-duty and able to wear respiratory protection.

6.2 Periodic Monitoring

In addition to a baseline physical, all employees require a periodic physical within the last 12 months unless the advising physician believes a shorter interval is appropriate. The employers medical consultant should prescribe an adequate medical which fulfills OSHA 29 CFR 1910.120 requirements. The preassignment medical outlined above may be applicable.

All personnel working in contaminated or potentially contaminated area's at the Site will verify currency (within 12 months) with respect to medical monitoring form.

6.3 Site Specific Medical Monitoring

For activities at the Site, the following specific tests will be required prior to individuals entering the Exclusion Zone or Contamination Reduction Zone.

- No site specific tests required.

6.4 Exposure/Injury/Medical Support

As a follow-up to an injury or possible exposure above established exposure limits, all employees are entitled to and encouraged to seek medical attention and physical testing. Depending upon the type of exposure, it is critical to perform follow-up testing within 24-48 hours. It will be up to the employers medical consultant to advise the type of test required to accurately monitor for exposure effects.

6.5 Exit Physical

At termination of employment or reassignment to an activity or location which does not represent a risk of exposure to hazardous substances, an employee shall require an exit physical. If his/her last physical was within the last 6 months, the advising medical consultant has the right to determine adequacy and necessity of exit exam.

7.0 FREQUENCY AND TYPES OF MONITORING/SAMPLING

This section explains the general concepts of an air monitoring program and specifies the surveillance activities that will take place during project completion at the Site.

The purpose of air monitoring is to identify and quantify airborne contaminants in order to verify and determine the level of worker protection needed. Initial screening for identification is often qualitative, i.e., the contaminant, or the class to which it belongs, is demonstrated to be present but the determination of its concentration (quantification) must await subsequent testing. Two principal approaches are available for identifying and/or quantifying airborne contaminants:

- o The on-site use of direct-reading instruments.
- o Laboratory analysis of air samples obtained by gas sampling bag, collection media (i.e., filter, sorbent), and/or wet-contaminant collection methods.

7.1 Direct-Reading Monitoring Instruments

Unlike air sampling devices, which are used to collect samples for subsequent analysis in a laboratory, direct-reading instruments provide information at the time of sampling, enabling rapid decision-making. Data obtained from the real-time monitors are used to assure proper selection of personnel protection equipment, engineering controls, and work practices. Overall, the instruments provide the user the capability to determine if site personnel are being exposed to concentrations which exceed exposure limits or action levels for specific hazardous materials.

Of significant importance, especially during initial entries, is the potential for IDLH conditions or oxygen deficient atmospheres. Real-time monitors can be useful in identifying any IDLH conditions, toxic levels of airborne contaminants, flammable atmospheres, or radioactive hazards. Periodic monitoring of conditions is critical, especially if exposures may have increased since initial monitoring or if new site activities have commenced.

Table 7.1. excerpted from Occupational Safety and Health Guidelines for Hazardous Waste Site Activities, provides an overview of available monitoring instrumentation and their specific operating parameters.

TABLE 7.1 SOME DIRECT-READING INSTRUMENTS FOR GENERAL SURVEY

Instrument: Combustible gas indicator (CGI)

Hazard Monitored: Combustible gases and vapors.

Application: Measures the concentration of a combustible gas or vapor.

Detection Method: A filament, usually made of platinum, is heated by burning the combustible gas or vapor. The increase in heat is measured. Gases and vapors are ionized in a flame. A current is produced in proportion to the number of carbon atoms present.

General Care/Maintenance: Recharge or replace battery. Calibrate immediately before use.

Typical Operating Time: Can be used for as long as the battery lasts, or for the recommended interval between calibrations, whichever is less.

Instrument: Flame Ionization Detector (FID) with Gas Chromatography Option.
Example: Foxboro OVA.

Hazard Monitored: Many organic gases and vapors.

Application: In survey mode, detects the concentration of many organic gases and vapors. In gas chromatography (GC) mode identifies and measures specific compounds. In survey mode, all the organic compounds are ionized and detected at the same time.

In GC mode, volatile species are separated.

General Care/Maintenance: Recharge or replace battery. Monitor fuel and/or combustion air supply gauges. Perform routine maintenance as described in the manual. Check for leaks.

Typical Operating Time: 8 hours; 3 hours with strip chart recorder.

Instrument: Portable Infrared (IR) Spectrophotometer

Hazard Monitored: Many gases and vapors.

Application: Measures concentration of many gases and vapors in air. Designed to quantify one or two component mixtures.

Detection Method: Passes different frequencies of IR through the sample. The frequencies absorbed are specific for each compound.

General Care/Maintenance: As specified by manufacturer.

Instrument: Ultraviolet (UV) Photoionization Detector (PID)

Example: HNU.

Hazard Monitored: Many organic and some inorganic gases and vapors.

Application: Detects total concentration of many organic and some inorganic gases and vapors. Some identification of compounds are possible if more than one probe is measured.

Detection Method: Ionizes molecules using UV radiation; produces a current that is proportional to the number of ions.

General Care/Maintenance: Recharge or replace battery. Regularly clean lamp window. Regularly clean and maintain the instrument and accessories.

Typical Operating Time: 10 hours. 5 hours with strip chart recorder.

Instrument: Direct Reading Colorimetric Indicator Tube

Hazard Measured: Specific gas and vapors.

Application: Measures concentration of specific gases and vapors.

Detection Method: The compound reacts with the indicator chemical in the tube, producing a stain whose length or color change is proportional to the compound's concentration.

General Care/Maintenance: Do not use a previously opened tube even if the indicator chemical is not stained. Check pump for leaks before and after use. Refrigerate before use to maintain a shelf life of about 2 years. Check expiration date of tubes. Calibrate pump volume at least quarterly. Avoid rough handling which may cause channeling.

Instrument: Oxygen Meter

Hazard Monitored: Oxygen (O₂)

Application: Measures the percentage of O₂ in the air.

Detection Method: Uses an electrochemical sensor to measure the partial pressure of O₂ in the air, and converts that reading to O₂ concentration.

General Care/Maintenance: Replace detector cell according to manufacturers recommendations. Recharge or replace batteries prior to expiration of the specified interval. If the ambient air is more than 0.5% CO₂, replace the detector cell frequently.

Typical Operating Time: 8-12 hours.

Instrument: Real Time Aerosol Monitor

Hazard Monitored: Particulates

Application: Measures total particulates in air.

Detection Method: Uses an internal light source. The particulates deflect the light beam and the amount of diffraction is converted into concentration (mg/m³).

General Care/Maintenance: Recharge batteries. Replace desiccant when necessary.

Typical Operating Time: 8-12 hours.

Instrument: Monitox

Hazard Monitored: Gases and Vapors

Application: Measures specific gases and vapors

Detection Method: Electrochemical sensor relatively specific for the chemical species in question.

General Care/Maintenance: Moisten sponge before use; check the function switch; change the battery when needed.

Instruments: Gamma Radiation Survey Instrument

Hazard Monitored: Gamma Radiation

Application: Environmental radiation monitor

Detection Method: Scintillation detector

General Care/Maintenance: Must be calibrated annually at a specialized facility.

Typical Operating Time: Can be used for as long as the battery lasts, or for the recommended interval between calibrations, whichever is less.

7.2 Air Sampling

After site mitigation activities have commenced, the selective monitoring of high-risk workers, i.e., those who are closest to the source of contaminant generation, is essential. Personal monitoring samples will be collected in the breathing zone and, if workers are wearing respiratory protective equipment, outside the facepiece.

Those employees working closest with the source have the highest likelihood of being exposed to concentrations which exceed established exposure limits. Representative sampling approaches emphasizing worst case conditions are acceptable. However, the sampling strategy may change if the operation or tasks change on-site or if exposures potentially increase.

Off-site air sampling will be conducted to quantify migration of airborne contaminants off site during removal operations.

7.3 Specific Contaminants to be monitored at the Site

The following checklist provides a summary of the contaminants to be monitored for and frequency/schedule of monitoring. The air sampling checklist will serve as a site monitoring plan.

7.4 Site Monitoring and Sampling Program

A. Monitoring Instruments

Real Time Aerosol Monitor

Continuous monitoring

Locations : Upwind and downwind of site activities
Excavation area

Organic Vapor Analyzer/Photoionization Detector

There is no evidence to indicate the presence of volatile organic contamination at the sites. Monitoring for volatile organic contaminants will be conducted if it is determined that drums have been buried at the site.

Radiation

Radiation surveys will be conducted prior to initiation of activities within the exclusion zone and each day after the completion of excavation activities.

B. Action Levels

Real Time Aerosol Monitor

The following action levels have been established for airborne contaminants at the sites. Should these action levels be exceeded dust suppression techniques will be employed to reduce the contaminant concentrations to acceptable levels. Dust suppression techniques include but are limited to wetting of soils prior to and during excavation, limiting excavations to periods of light or no winds and covering soil stockpiles while not in use. If dust suppression techniques are ineffective operations will cease until dust suppression is achieved. Action levels may be changed after review of air sampling data results.

Within Exclusion Zone

3x background

Off-site

1.5x background, 100 feet downwind of exclusion zone

Organic Vapors

- > 1 unit - upgrade to level C
- > 5 units - upgrade to level B
- > 500 units - upgrade to level A

Radiation Meter

- > 3x background (0.01-0.02mR/hr) - Use Caution. Dose rate is below NRC dose rate for a normal 8-hour day.**
- > 0.5 mR/hr - Radiation dose monitoring is required for continuous, full-day exposures over this level.**
- > 1mR/hr - Leave area consult a Radiation Health Physicist**

C. Reporting Format

The results of all site monitoring will be recording in the site logbook.

Air samples will be collected at the initiation of excavation/earth moving operations and analyzed for the contaminants of concern. The objective of this sampling is to quantify the potential exposure to airborne contaminants. A sample will be collected at the work station of the worker anticipated to be exposed to the greatest concentration of contaminants. In addition samples will be collected upwind and downwind of the excavation to quantify the level of airborne contaminants migrating beyond the limits of the exclusion zone.

8.0 SITE CONTROL MEASURES

The following section defines measures and procedures for maintaining site control. Site control is an essential component in the implementation of the site health and safety program.

8.1 Buddy System

During all Level B activities or when some conditions present a risk to personnel, the implementation of a buddy system is mandatory. A buddy system requires at least two people who work as a team; each looking out for each other. For example, Level B operations generally require three people.

8.2 Site Communications Plan

Successful communications between field teams and contact with personnel in the support zone is essential. The following communications systems will be available during activities at the Site.

- o Intrinsically safe radio
- o Hand Signals

Signal	Definition
Hands clutching throat	Out of air/cannot breathe
Hands on top of head	Need assistance
Thumbs up	OK/I am all right/I understand
Thumbs down	No/negative
Arms waving upright	Send backup support
Grip partners wrist	Exit area immediately

8.3 Work Zone Definition

The three general work zones established at the Site are the Exclusion Zone, Contamination Reduction Zone, and Support Zone. Figure 8.1 provides a site map with the work zones designated on it.

The Exclusion Zone is defined as the area where contamination is either known or likely to be present, or because of activity, will provide a potential to cause harm to personnel. Entry into the Exclusion Zone requires the use of personnel protective equipment.

The Contamination Reduction Zone is the area where personnel conduct personal and equipment decontamination. It is essentially a buffer zone between

contaminated areas and clean areas. Activities to be conducted in this zone will require personal protection as defined in the decontamination plan. The Support Zone is situated in clean areas where the chance to encounter hazardous materials or conditions is minimal. Personal protective equipment is therefore not required.

8.4 Nearest Medical Assistance

Figure 8.2 provides a map of the route to the nearest medical facility which can provide emergency care for individuals who may experience an injury or exposure on-site. The route to the hospital should be verified by the HSO, and should be familiar to all site personnel.

The following individuals on site have current certification in CPR and/or first aid:

- Eric Wilson,
- James D. Harkay

8.5 Safe Work Practices

Table 8.2 provides a list of standing orders for the Exclusion Zone.

Table 8.3 provides a list of standing orders for the Contamination Reduction Zone.

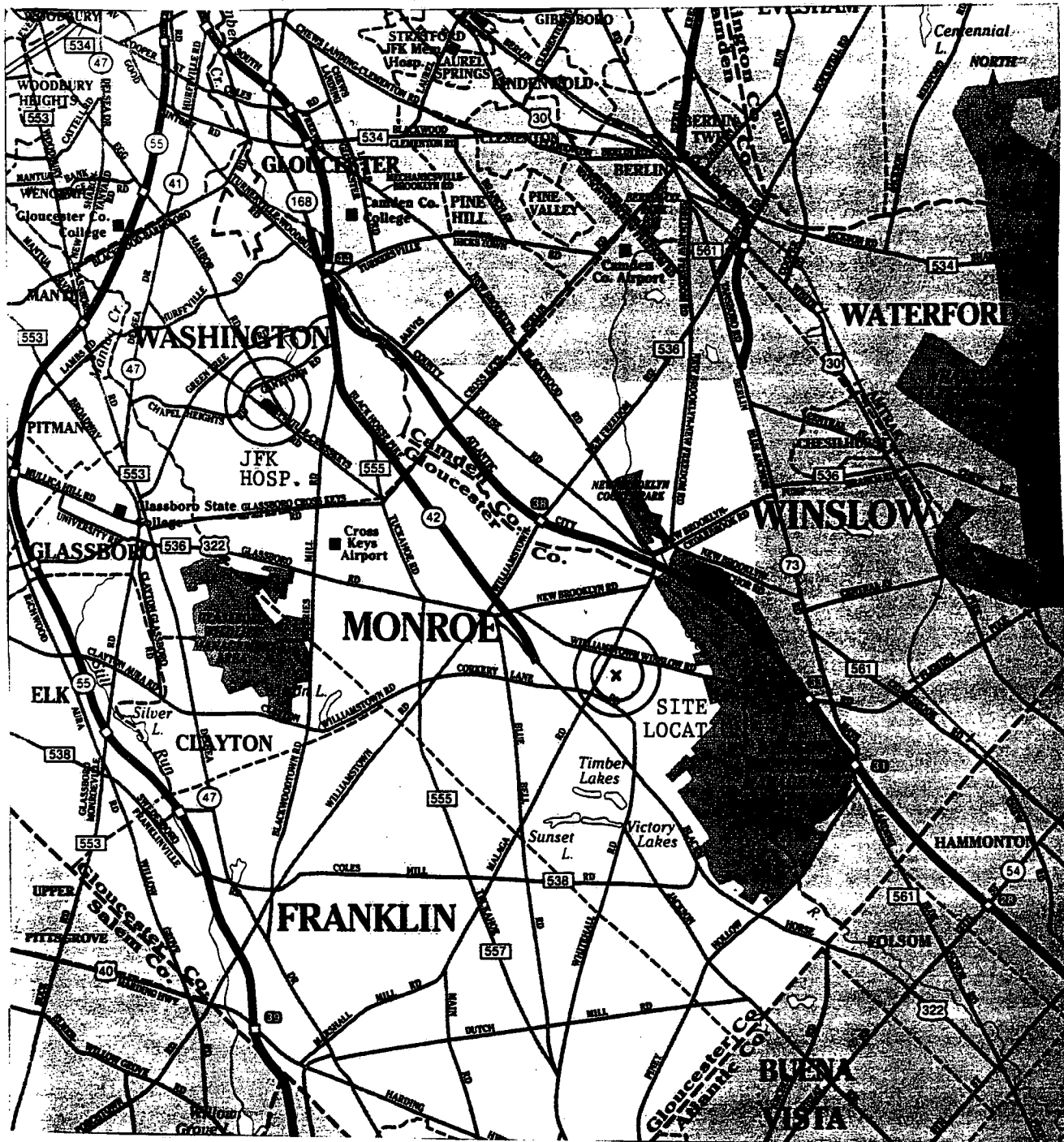
8.6 Emergency Alarm Procedures

The warning signals described in section 10.4 "Evacuation Routes and Procedures," will be deployed in the event of an emergency. Communication signals will also be used according to section 8.2.

FIGURE 8.1
SITE MAP DEPICTING WORK ZONES

[to be included after setup of work zones and support facilities]

FIGURE 8.2
MAP TO NEAREST HOSPITAL



Roy F. Weston, Inc.
MAJOR PROGRAMS DIVISION

IN ASSOCIATION WITH FOSTER WHEELER CORP.,
C.C. JOHNSON & MALHOTRA, P.C., RESOURCE
APPLICATIONS, INC. AND R.E. SARRIERA ASSOCIATES

EPA PM
D. HARKAY

TAT PM
E. WILSON

ROUTE TO
HOSPITAL

MONROE/MALAGA
BURN SITES

TABLE 8.2 STANDING ORDERS FOR EXCLUSION ZONE

- No smoking, eating, or drinking in this zone.
- No horse play.
- No matches or lighters in this zone.
- Check-in on entrance to this zone.
- Check-out on exit from this zone.
- Implement the communications system.
- Line of sight must be in position.
- Wear the appropriate level of protection as defined in the Safety Plan.

TABLE 8.3 STANDING ORDERS FOR CONTAMINATION REDUCTION ZONE

- No smoking, eating, or drinking in this zone.
- No horse play.
- No matches or lighters in this zone.
- Wear the appropriate level of protection.

9.0 DECONTAMINATION PLAN

Table 5.2 lists the tasks and specific levels of protection required for each task. Consistent with the levels of protection required, the decontamination figure provides a step by step representation of the personnel decontamination process for either level A, B, or C. These procedures should be modified to suit site conditions and protective ensembles in use.

9.1 Standard Operating Procedures

Decontamination involves the orderly controlled removal of contaminants. Standard decontamination sequences are presented in the decontamination figure. All site personnel should minimize contact with contaminants in order to minimize the need for extensive decon.

9.2 Levels of Decontamination Protection Required for Personnel

The levels of protection required for personnel assisting with decontamination will be Level D.

The Site Safety Officer is responsible for monitoring decontamination procedures and determining their effectiveness.

9.3 Equipment Decontamination

Sampling equipment will be decontaminated in accordance with procedures as defined in the sampling plan. The sequence of decontamination steps required for non-sampling equipment and heavy machinery is as follows:

- o remove all loose dirt and transfer to exclusion zone or waste pile
- o wash with steam genny or power washer, collect and retain rinsate

9.4 Disposition of Decontamination Wastes

All equipment and solvents used for decontamination shall be decontaminated or disposed of properly. Commercial laundries or cleaning establishments that decontaminate protective clothing or equipment shall be informed of the potentially harmful effects of exposures.

FIGURE 9.1
LEVEL A DECONTAMINATION STEPS

- | | |
|---------|---|
| Step 1 | Segregated equipment drop |
| Step 2 | Boot cover and glove wash |
| Step 3 | Boot cover and glove rinse |
| Step 4 | Tape removal - boot and glove |
| Step 5 | Boot cover removal |
| Step 6 | Outer glove removal |
| Step 7 | Suit/safety boot wash |
| Step 8 | Suit/safety boot rinse |
| Step 9 | Safety boot removal |
| Step 10 | Fully encapsulating suit and hard hat removal |
| Step 11 | SCBA backpack removal |
| Step 12 | Inner glove wash |
| Step 13 | Inner glove rinse |
| Step 14 | Face piece removal |
| Step 15 | Inner glove removal |
| Step 16 | Inner clothing removal |
| Step 17 | Field wash |
| Step 18 | Redress |

FIGURE 9.2
LEVEL B DECONTAMINATION STEPS

- | | |
|---------|-------------------------------------|
| Step 1 | Segregated equipment drop |
| Step 2 | Boot cover and glove wash |
| Step 3 | Boot cover and glove rinse |
| Step 4 | Tape removal - outer glove and boot |
| Step 5 | Boot cover removal |
| Step 6 | Outer glove removal |
| Step 7 | Suit/safety boot wash |
| Step 8 | Suit/SCBA/boot/glove rinse |
| Step 9 | Safety boot removal |
| Step 10 | SCBA backpack removal |
| Step 11 | Splash suit removal |
| Step 12 | Inner glove wash |
| Step 13 | Inner glove rinse |
| Step 14 | Face piece removal |
| Step 15 | Inner glove removal |
| Step 16 | Inner clothing removal |
| Step 17 | Field wash |
| Step 18 | Redress |

FIGURE 9.3
LEVEL C DECONTAMINATION STEPS

- | | |
|--------|----------------------------|
| Step 1 | Segregated equipment drop |
| Step 2 | Tape removal |
| Step 3 | Boot cover removal |
| Step 4 | Outer glove removal |
| Step 5 | Splash suit removal |
| Step 6 | Face piece removal |
| Step 7 | Inner glove removal |
| Step 8 | Field wash (If Applicable) |

FIGURE 9.4
LEVEL D DECONTAMINATION STEPS

- Step 1 Remove outer garments (i.e., coveralls)
- Step 2 Remove gloves
- Step 3 Wash hands and face

10.0 EMERGENCY RESPONSE/CONTINGENCY PLAN

This section describes contingencies and emergency planning procedures to be implemented at the Site. This plan is compatible with local, state and federal disaster and emergency management plans as appropriate.

10.1 Pre-Emergency Planning

During the site briefings held periodically/daily, all employees will be trained in and reminded of provisions of the emergency response plan, communication systems, and evacuation routes. Table 10.1 identifies the hazardous conditions associated with specific site activities. The plan will be reviewed and revised if necessary, on a regular basis by the HSO. This will ensure that the plan is adequate and consistent with prevailing site conditions.

10.2 Personnel Roles and Lines of Authority

The Site Supervisor has primary responsibility for responding to and correcting emergency situations. This includes taking appropriate measure to ensure the safety of site personnel and the public. Possible actions may involve evacuation of personnel from the site area, and evacuation of adjacent residents. He/she is additionally responsible for ensuring that corrective measures have been implemented, appropriate authorities notified, and follow-up reports completed. The HSO may be called upon to act on the behalf of the site supervisor, and will direct responses to any medical emergency. The individual contractor organizations are responsible for assisting the project manager in his/her mission within the parameters of their scope of work.

The Site Supervisor(s): James D. Harkay.

The HSO is James D. Harkay

Alternates are:

- o Eric Wilson

10.3 Emergency Recognition/Prevention

Table 3.1 provides a listing of chemical and physical hazards on-site. Additional hazards as a direct result of site activities are listed in Table 10.1 as are prevention and control techniques/mechanisms. Personnel will be familiar with techniques of hazard recognition from preassignment training and site specific briefings. The HSO is responsible for ensuring that prevention devices or equipment is available to personnel.

10.4 Evacuation Routes/Procedures

In the event of an emergency which necessitates an evacuation of the site, the following alarm procedures will be implemented:

Evacuation alarm notification should be made using three short blasts on the air horn, supplemented using the hand held radios. All personnel should evacuate upwind of any activities. Insure that a predetermined location is identified off-site in case of an emergency, so that all personnel can be accounted for.

Personnel will be expected to proceed to the closest exit with your buddy, and mobilize to the safe distance area associated with the evacuation route. Personnel will remain at that area until the re-entry alarm is sounded or an authorized individual provides further instructions.

Figure 10.1 provides a map depicting evacuation routes for the site and immediate area. Also indicated are muster areas and safe distances in the event of a major incident.

TABLE 10.1
EMERGENCY RECOGNITION/CONTROL MEASURES

HAZARD -----	PREVENTION/CONTROL -----	LOCATION -----
Fire/Explosion	Fire Extinguisher	Crew Trailer & Office Trailer
	Alarm System/Air Horn	Transition Zone & Office Trailer
Spill	Berms/Dikes	Surrounding Diesel Storage Tank
	Sorbent Materials	Decon Trailer
Air Release	Water Spray	
	Alarm System/Air Horn	Transition Zone & Office Trailer
	Evacuation Routes	Posted in Transition Zone

10.5 Emergency Contact/Notification System

The following list provides names and telephone numbers for emergency contact personnel. In the event of a medical emergency, personnel will take direction from the HSO and notify the appropriate emergency organization. In the event of a fire or spill, the site supervisor will notify the appropriate local, state, and federal agencies.

Organization	Contact	Telephone
Ambulance:	N/A	(609) 728-0800 ¹
Police:	Monroe Twp. Police Dept.	(609) 728-0800 ¹
Fire:	Malaga Fire Dept.	(609) 728-0800 ¹ or 911
State Police:	NJ State Police Bellmawr Station	(609) 933-0550
Hospital:	Kennedy Memorial Hosp. Washington, NJ	(609) 582-2500
WESTON 24 hr. Hotline		(215) 524-1925 (215) 524-1926
WESTON Medical Emergency Service		(800) 229-3674
Poison Control Center		(800) 942-5969
Regional EPA:		(908) 548-8730
EPA Emergency Response Team		(908) 321-6660
State Authority: NJDEPE		(609) 426-0799
National Response Center		800-424-8802
Center for Disease Control		404-488-4100
Chemtrec		800-424-9555

1 - Instructed by Monroe Township Police Department to contact the Police in the event of and Emergency

FIGURE 10.1
EVACUATION ROUTES AND SAFE DISTANCES

[to be included after setup of work zones and support facilities]

10.6 Emergency Medical Treatment Procedures

Any person who becomes ill or injured in the exclusion zone must be decontaminated to the maximum extent possible. If the injury or illness is minor, full decontamination should be completed and first aid administered prior to transport. If the patient's condition is serious, at least partial decontamination should be completed (i.e., complete disrobing of the victim and redressing in clean coveralls or wrapping in a blanket.) First aid should be administered while awaiting an ambulance or paramedics. All injuries and illnesses must immediately be reported to the project manager.

Any person being transported to a clinic or hospital for treatment should take with them information on the chemical(s) they have been exposed to at the site. This information is included in Table 3.1.

Any vehicle used to transport contaminated personnel will be treated and cleaned as necessary.

10.7 Fire or Explosion

In the event of a fire or explosion, the local fire department should be summoned immediately. Upon their arrival, the project manager or designated alternate will advise the fire commander of the location, nature, and identification of the hazardous materials on-site.

If it is safe to do so, site personnel may:

- o Use fire fighting equipment available on-site to control or extinguish the fire; and,
- o Remove or isolate flammable or other hazardous materials which may contribute to the fire.

10.8 Spill or Leaks

In the event of a spill or a leak, site personnel will:

- o Inform their supervisor immediately;
- o Locate the source of the spillage and stop the flow if it can be done safely; and,
- o Begin containment and recovery of the spilled materials.

10.9 Emergency Equipment/Facilities

Figure 10.2 provides a map of the site and identifies the location of the following emergency equipment:

- o First aid kit
- o Fire extinguisher
- o Site telephone
- o Eye wash
- o Two-way radio
- o Air horn

FIGURE 10.2
SITE MAP WITH EMERGENCY EQUIPMENT LOCATED

[to be included after setup of support facilities]

11.0 SPILL CONTAINMENT PROGRAM

The procedures defined in this section comprise the spill containment program in place for activities at the Site.

- All drums and containers used during the clean-up shall meet the appropriate DOT, OSHA, and EPA regulations for the waste that they will contain.
- Drums and containers shall be inspected and their integrity assured prior to being moved. Drums or containers that cannot be inspected before being moved because of storage conditions, shall be positioned in an accessible location and inspected prior to further handling.
- Operations on site will be organized so as to minimize the amount of drum or container movement.
- Employees involved in the drum or container operations shall be warned of the hazards associated with the containers.
- Where spills, leaks, or ruptures may occur, adequate quantities of spill containment equipment (absorbent, pillows, etc.) will be stationed in the immediate area. The spill containment program must be sufficient to contain and isolate the entire volume of hazardous substances being transferred.
- Drums or containers that cannot be moved without failure, shall be emptied into a sound container.
- Fire extinguishing equipment meeting 29 CFR part 1910. subpart 1 shall be on hand and ready for use to control fires.

12.0 HAZARD COMMUNICATION

In order to comply with 29 CFR 1910.1200, Hazard Communication, the following written Hazard Communication Program has been established. All employees will be briefed on this program, and have a written copy for review.

A. CONTAINER LABELING

All containers received on site will be inspected to ensure the following: (1) all containers will be clearly labeled as to the contents; (2) the appropriate hazard warnings will be noted; and (3) the name and address of the manufacturer will be listed.

All secondary containers will be labeled with either an extra copy of the original manufacturer's label or with generic labels which have a block for identity and blocks for the hazard warning.

B. MATERIAL SAFETY DATA SHEETS (MSDSs)

Copies of MSDSs for all hazardous chemicals known or suspected on site will be maintained in the work area. MSDSs will be available to all employees for review during each work shift. MSDS's can be found in Attachment A of this Health and Safety Plan.

C. EMPLOYEE TRAINING AND INFORMATION

Prior to starting work, each employee will attend a health and safety orientation and will receive information and training on the following: (1) an overview of the requirements contained in the Hazard Communication Standard, 29 CFR 1910.1200; (2) chemicals present in their work place operations; (3) location and availability of a written hazard program; (4) physical and health effects of the hazardous chemicals; (5) methods and observation techniques used to determine the presence or release of hazardous chemicals; (6) how to lessen or prevent exposure to these hazardous chemicals through usage of control/work practices and personal protective equipment; (7) emergency procedures to follow if they are exposed to these chemicals; (8) how to read labels and review MSDSs to obtain appropriate hazard information; (9) location of MSDS file and location of hazardous chemical list.

Attachment A

Material Safety Data Sheets (MSDS)



Genium Publishing Corporation

1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 70
Antimony Metal/Powder

Issued: 9/80

Revision: A, 11/89

Section 1. Material Identification

30

Antimony Metal/Powder Description: A naturally occurring ore found in sulfides, oxides, complex lead, silver, copper, and mercury sulfides. Prepared in the laboratory by reducing Sb_2O_3 with KCN. Used in manufacturing bullets, bearing metal, hard lead, blackening iron, coating metals, white metal, thermoelectric piles, storage batteries, cable sheaths, type metal, and alloys (Britannia or Babbitt metal). Pure antimony compounds are used as catalysts in organic synthesis, abrasives, plasticizers, pigment, and flameproofing compounds; also used in manufacturing paints, enamels, matches, glass, pharmaceuticals, explosives, and tartar emetic.

Other Designations: Stibium; antimony regulus; Sb; CAS No. 7440-36-0.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.

R 1
I 3
S 3
K 1

Genium



HMIS

H 3

F 1

R 1

PPG*

* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Antimony, ca 99%

OSHA PEL

8-hr TWA: 0.5 mg/m³ (as Sb)

ACGIH TLV, 1989-90

TLV-TWA: 0.5 mg/m³ (as Sb)

NIOSH REL, 1987*

10-hr TWA: 0.5 mg/m³

Toxicity Data†

Rat, intraperitoneal, LD₅₀: 100 mg/kg

Rat, oral, LD₅₀: 100 mg/kg

* NIOSH has proposed a 10-hr TWA of 0.5 mg/m³ with an action level at 0.25 mg/m³. The TLV was established at a level to prevent irritation and systemic effects.
† See NIOSH, RTECS (CC4025000), for additional data with references to toxic effects.

Section 3. Physical Data

Boiling Point: 2975 °F (1635 °C)

Melting Point: 1166.9 °F (630.5 °C)

Vapor Pressure: 1 mm Hg at 1627 °F (886 °C)

Molecular Weight: 121.76 g/mol

Specific Gravity ($\text{H}_2\text{O} = 1$ at 39 °F (4 °C)): 6.68 at 77 °F (25 °C)

Water Solubility: Insoluble

Mohs Hardness: 3.0 to 3.5

Appearance and Odor: A brittle, flaky, crystalline solid with a lustrous blue-white color; however, a noncrystalline form is also known. The powder form is dark gray, lustrous.

Section 4. Fire and Explosion Data

Flash Point: None reported

Autoignition Temperature: Cloud,* 788 °F (420 °C); dust layer,* 626 °F (330 °C)

LEL: Dust cloud explosion, 0.42 oz/ft³

UEL: None reported

Extinguishing Media: Dry chemical powder.

Unusual Fire or Explosion Hazards: Antimony bulk metal is combustible in air at *high temperature*. When ignited it burns with a brilliant flame, giving off dense, white antimony trioxide (Sb_2O_3) fumes. When exposed to heat or ignition sources, powdered antimony is a moderate fire and explosion hazard. Particle size and dispersion in air determine reactivity.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Personal protective clothing and eye protection are essential.

* Ninety-one percent of dust goes through a 74- μm sieve. A 1.92-J spark can ignite an antimony dust cloud.

Section 5. Reactivity Data

Stability/Polymerization: Antimony metal (bulk) is stable in dry air at room temperature in closed containers. It slowly tarnishes in moist air. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Antimony is not very reactive with cold, dilute acids, but it reacts readily with aqua regia and hot, concentrated sulfuric acid. Powdered antimony* also reacts with hot, concentrated hydrochloric acid (HCl). On contact with acid, it emits toxic antimony trihydride (SbH_3) fumes; electrolysis of acid sulfides and stirred antimony halide yields explosive antimony. Antimony can react vigorously or violently with oxidizing agents such as nitrate salts, halogens, nitric acid, perchloric acids, chlorine trifluoride (ClF_3), potassium permanganate (KMnO_4), ammonium nitrate (NH_4NO_3), bromine trinitride (BrN_3), bromine trifluoride (BrF_3), chlorine monoxide (ClO), chlorine trifluoride (ClF_3), potassium nitrate (KNO_3), sodium nitrate (NaNO_3), and potassium oxide (K_2O).

Conditions to Avoid: Nascent hydrogen can react with Sb, or its alloys with Mg or Zn, to form antimony trihydride, a colorless, highly toxic gas (causing headache, nausea, vomiting, abdominal pain, hemolysis (separation of hemoglobin from red blood corpuscles), hematuria (blood in the urine), and death) with a disagreeable odor (0.1-ppm TLV).

Hazardous Products of Decomposition: Thermal oxidative decomposition of antimony can produce toxic SbH_3 fumes.

* Powdered antimony reacts more vigorously than the bulk material and forms dangerous mixtures with oxidizing agents. Heating further increases its reactivity.

Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists antimony as a carcinogen. However, its ore is a suspected carcinogen in antimony trioxide production. Antimony trioxide is prepared in the laboratory by a volatilization process involving antimony trichloride (SbCl_3) and water.

Summary of Risks: An irritant to mucous membranes, eyes, and skin. Exposures to dust/powder can cause eye inflammation (conjunctivitis), nasal irritation (rhinitis - perforation of the nasal septum), chronic dermatitis ranging from mild rashes to blemishes resembling chicken pox, and muscle pain and weakness. Some sources refer to antimony as a human poison by an unspecified route. Exposure to antimony may result in "metal fume fever," a flu-like syndrome with fever, fatigue, cough, and muscle ache.

Medical Conditions Aggravated by Long-Term Exposure: Chronic inhalation of subtoxic doses of dust or fume above the TLV may result in chemical pneumonia, intraalveolar lipid deposits, liver and cardiac involvement, and possible kidney disease.

Target Organs: Skin, eyes, mucous membranes, respiratory system, and cardiovascular system.

Primary Entry: Inhalation (dust and fume), ingestion.

Acute Effects: Acute ingestion may cause violent vomiting, diarrhea, slow pulse and low blood pressure, shallow breathing, and death.

Chronic Effects: Chronic exposures lead to dizziness, dry throat, sleeplessness, anorexia, and nausea.

FIRST AID

Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.

Skin: After rinsing affected area with flooding amounts of water, wash it with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: *Contact physician!* Never give anything by mouth to an unconscious or convulsing person. Give 1 to 2 glasses of water to dilute, although vomiting may be spontaneous after ingestion.

After first aid, get appropriate in-plant, paramedic, or community medical attention and support.

Physician's Note: If indicated, intravenous gastric lavage chelation therapy with BAL (British Anti-Lewisite) for 10 days is recommended.

Spill/Leak: Notify safety personnel of powder spills. Small spills can be removed by vacuuming or wet sweeping to minimize airborne dust. Cleanup personnel should use protective equipment.

Disposal: Return scrap metal to your supplier. Unsalvageable waste may be buried in an approved secure landfill. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 5000 lb (2270 kg) [* per Clean Water Act, Sec. 307(a)]

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Wear a NIOSH-approved respirator if necessary. Follow OSHA respirator regulations (29 CFR 1910.134). Respirators should be available for nonroutine or emergency use for concentrations above the TLV: high-efficiency dust respirators for concentrations below 5 mg/m^3 and self-contained or air-supplied respirators with full facepiece for concentrations above 5 mg/m^3 .

Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.

Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL standard (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103).

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in a dry, well-ventilated, low fire-risk area. Avoid heat and direct sunlight.

Engineering Controls: Avoid breathing dust or fumes. Practice good housekeeping and cleaning techniques to prevent dust accumulation and to minimize airborne particulates. Minimize skin contact by using barrier creams, rubber gloves and aprons, and good personal hygiene. Keep antimony dust off clothing. Provide preplacement and periodic medical examinations for those workers exposed regularly to antimony, with emphasis on the skin, mucous membranes, and the pulmonary, cardiac, and reproductive systems. Provide suitable training to those working with antimony. Monitor the workplace. Keep records.

Transportation Data (49 CFR 172.102)

IMO Shipping Name: Antimony compounds, inorganic, n.o.s.

IMO Hazard Class: 6.1

IMO Label: Poison/St. Andrews Cross (Stow away from foodstuffs)

IMDG Packaging Group: I, II, III

MSDS Collection References: 1, 2-12, 24, 26, 27, 31, 37, 38, 41, 81, 84, 87, 89, 90, 91, 100, 109

Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD



Genium Publishing Corporation

1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 296
Arsenic and Compounds

Issued: 4/90

Section 1. Material Identification

31

Arsenic Description: Obtained from flue dust of copper and lead smelters as white arsenic (arsenic trioxide). Reduction with charcoal and sublimation in an N_2 current yields pure arsenic. Metallic arsenic is used for hardening copper, lead, and alloys; as a doping agent in germanium and silicon solid-state products, special solders, and medicine; and to make gallium arsenide for diodes and other electronic devices. Arsenic compounds are used in manufacturing certain types of glass; in textile printing, tanning, taxidermy, pharmaceuticals, insecticides and fungicides, pigment production, and antifouling paints; and to control sludge formation in lubricating oils. Arsenic trioxide is the source for 97% of all arsenic products.

Other Designations: CAS No. 7440-38-2; arsen; arsenic black; As; gray arsenic; metallic arsenic.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*^(TM) for a suppliers list.

R 1
I 4
S 2
K 0

Genium



HMIS

H 3

F 2

R 2

PPG*

* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Arsenic and soluble compounds, as As

OSHA PEL

8-hr TWA: 0.5 mg/m³,* 0.01 mg/m³†

NIOSH REL, 1987

Ceiling: 0.002 mg/m³

Toxicity Data‡

Man, oral, TD₀₁: 76 mg/kg administered intermittently over a 12-year period affects the liver (tumors) and blood (hemorrhage)

Man, oral: 7857 mg/kg administered over 55 years produces gastrointestinal (in the structure or function of the esophagus), blood (hemorrhage), and skin and appendage (dermatitis) changes

Rat, oral, TC₀₁: 605 µg/kg administered to a 35-week pregnant rat affects fertility (pre- and post-implantation mortality)

ACGIH TLV, 1989-90

TLV-TWA: 0.2 mg/m³

* Organic compounds.

† Inorganic compounds.

‡ See NIOSH, *RTECS* (CG0525000), for additional mutative, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data*

Boiling Point: sublimates at 1134 °F/612 °C

Melting Point: 1497 °F/814 °C

Vapor Pressure: 1 mm at 702 °F/372 °C (sublimes)

Atomic Weight: 74.92

Density: 5.724 at 57 °F/14 °C

Water Solubility: Insoluble†

Appearance and Odor: A brittle, crystalline, silvery to black metalloid. Odorless.

* This data pertains to arsenic only.

† Arsenic is soluble in nitric acid (HNO₃).

Section 4. Fire and Explosion Data

Flash Point: None reported

Autoignition Temperature: None reported

LEL: None reported

UEL: None reported

Extinguishing Media: Use dry chemical, CO₂, water spray, or foam to fight fires.

Unusual Fire or Explosion Hazards: Flammable and slightly explosive in the form of dust when exposed to heat or flame.

Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Arsenic is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Arsenic can react vigorously on contact with powerful oxidizers such as bromates, peroxides, chlorates, iodates, lithium, silver nitrate, potassium nitrate, potassium permanganate, and chromium (VI) oxide. This material is also incompatible with halogens, bromine azide, palladium, dirubidium acetylide, zinc, and platinum.

Hazardous Products of Decomposition: Thermal oxidative decomposition of arsenic and its compounds produces irritating or poisonous gases.

Section 6. Health Hazard Data

Carcinogenicity: The IARC, NTP, and OSHA list arsenic as a human carcinogen (Group 1). This evaluation applies to arsenic and arsenic compounds as a whole, and not necessarily to all individual chemicals within the group. Studies report that both the trivalent and pentavalent compounds are strongly implicated as causes of skin, lung, and lymphatic cancers. Experimental studies have shown that arsenic has tumor- and teratogenic effects in laboratory animals.

Summary of Risks: Arsenic compounds are irritants of the skin, mucous membranes, and eyes. The moist mucous membranes are most sensitive to irritation. Prolonged contact results in local hyperemia (blood congestion) and later vesicular or pustular eruption. Epidermal carcinoma is a reported risk of exposure. Peripheral neuropathy (degenerative state of the nervous system) is common after acute or chronic arsenic poisoning. Symptoms include decreased sensation to touch, pinprick, and temperature; loss of vibration sense; and profound muscle weakness and wasting. Other complications of acute and chronic arsenic poisoning are encephalopathy (alterations of brain structure) and toxic delirium.

Medical Conditions Aggravated by Long-Term Exposure: Damage to the liver, nervous, and hematopoietic (responsible for the formation of blood or blood cells in the body) system may be permanent. Pulmonary and lymphatic cancer may also occur.

Target Organs: Liver, kidneys, skin, lungs, lymphatic system.

Primary Entry Routes: Inhalation, ingestion of dust and fumes, via skin absorption.

Acute Effects: Acute industrial intoxication is more likely to arise from inhalation of arsine. However, with corrosive arsenical vapors, conjunctivitis, eyelid edema, and even corneal erosion may result. Inhalation may result in nasal irritation with perforation of the septum, cough, chest pain, hoarseness, pharyngitis, and inflammation of the mouth. If ingested, metallic or garlic taste, intense thirst, nausea, vomiting, abdominal pain, diarrhea, and cardiovascular arrhythmias (heartbeat irregularities) may occur. Symptoms generally occur within 30 minutes, but may be delayed for several hours if ingested with food. Acute poisoning may result in acute hemolysis (breakdown of red blood cells).

Chronic Effects: Chronic symptoms include weight loss, hair loss, nausea, and diarrhea alternating with constipation, palmar and plantar hyperkeratosis (thickening of the corneous layer of skin on palms and soles of feet), and skin eruptions, and peripheral neuritis (inflammation of the nerves). Leukemia, bone marrow depression, or aplastic anemia (dysfunctioning of blood-forming organs) may occur after chronic exposure.

FIRST AID

Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.

Skin: Quickly remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have a conscious person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Physician's Note: If emesis is unsuccessful after two doses of ipecac, consider gastric lavage. Monitor urine arsenic level. Alkalinization of urine may help prevent disposition of red cell breakdown products in renal tubular cells. If acute exposure is significant, maintain high urine output and monitor volume status, preferably with central venous pressure line. Abdominal X-rays should be done routinely for all ingestions. Chelation therapy with BAL, followed by n-penicillamine is recommended, but specific dosing guidelines are not clearly established.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of spill, evacuate all unnecessary personnel, remove all heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against dust inhalation and contact with skin and eyes. Use nonsparking tools. With a clean shovel, scoop material into a clean, dry container and cover. Absorb liquid material with sand or noncombustible inert material and place in disposal containers. Do not release to sewers, drains, or waterways. Follow applicable OSHA regulations (29 CFR 1910.120).

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations*

RCRA Hazardous Waste (40 CFR 261.33): Not listed

Listed as a CERCLA Hazardous Substance† (40 CFR 302.4), Reportable Quantity

(RQ): 1 lb (0.454 kg) [† per Clean Water Act, Sec. 307(a); per Clean Air Act, Sec. 112]

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations†

Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

* Designations for arsenic only.

† Listed as arsenic organic compounds (as As).

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.

Warning: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.

Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PELs, ACGIH TLVs, and NIOSH REL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.⁽¹⁰⁵⁾

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed, properly labeled, containers in a cool, well-ventilated area away from all incompatible materials (Sec. 5) and heat and ignition sources. Protect containers from physical damage.

Engineering Controls: Avoid inhalation or ingestion of dust and fumes, and skin or eye contact. Practice good personal hygiene and housekeeping procedures. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program with training, maintenance, inspection, and evaluation. All engineering systems should be of maximum explosion-proof design and electrically grounded and bonded. Provide preplacement and annual physical examination with emphasis on the skin, respiratory system, and blood.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Arsenic, solid

IMO Shipping Name: Arsenic, metallic

DOT Hazard Class: Poison B

IMO Hazard Class: 6.1

ID No.: UN1558

IMO Label: Poison

DOT Label: Poison

IMDG Packaging Group: II

DOT Packaging Requirements: 173.366

ID No.: UN1558

DOT Packaging Exceptions: 173.364

MSDS Collection References: 7, 26, 38, 53, 73, 85, 87, 88, 89, 100, 103, 109, 123, 124, 126, 127, 130, 136, 138

Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD



Genium Publishing Corporation

1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 297
Barium and Compounds

Issued: 4/90

Section 1. Material Identification

Barium and Compounds Description: Produced by reducing barium oxide with aluminum or silicon in a vacuum at high temperature. The minerals barite (BaSO_4) and witherite (BaCO_3) are the primary sources of barium. Used as lubricant for anode rotors in X-ray tubes; a deoxidizer for copper; an extender in paints; a loader for paper, soap, rubber, and linoleum; a carrier for radium; a fire extinguisher for uranium or plutonium fires; a rodenticide; a stabilizer and mold lubricant in the rubber and plastics industries; a flux for magnesium alloys; getter alloys in vacuum tubes; and in spark-plug alloys and Fray's metal. Important barium compounds include carbonate (ceramics, rodenticide), sulfate (pigment and filler), hydroxide (water treatment, ceramics), nitrate (pyrotechnics), chloride (chemicals), chromate (pigments), oxide (lubricants), and peroxide (bleach).

Other Designations: CAS No. 7440-39-3; Ba.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*⁽⁷⁾ for a suppliers list.

R 2
I 3
S 2
K 4

Genium



HMIS

H 2

F 2

R 4

PPG*

* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Barium, ca 100%

OSHA PEL

8-hr TWA: 0.5 mg/m³ (Barium, soluble compounds, as Ba)

NIOSH REL, 1987

None established

Toxicity Data*

None listed

ACGIH TLV, 1989-90

TLV-TWA: 0.5 mg/m³ (Barium, soluble compounds, as Ba)

* Monitor RTECS (CQ8370000), for additional future data.

Section 3. Physical Data*

Boiling Point: 2984 °F/1640 °C

Melting Point: 1337 °F/725 °C

Vapor Pressure: 10 mm Hg at 1920 °F/1049 °C

Molecular Weight: 137.33 g/mol

Specific Gravity ($\text{H}_2\text{O} = 1$ at 39 °F/4 °C): 3.51 at 68 °F/20 °C

Water Solubility: Insoluble

Appearance and Odor: A silver white metal that is slightly lustrous and somewhat malleable.

Comment: Barium has a distinctive property of absorbing gases.

* Physical data are for barium only.

Section 4. Fire and Explosion Data

Flash Point: None reported

Autoignition Temperature: None reported

LEL: None reported

UEL: None reported

Extinguishing Media: Do not use water or foam. For small fires, use dry chemical, soda ash, lime, or sand. For large fires, withdraw from area and let fire burn.

Unusual Fire or Explosion Hazards: In the powder form, barium is flammable at room temperature. It is also explosive in the form of dust when exposed to heat, flame, or by chemical reaction. The chlorate, peroxide, and nitrate compounds are reactive and may present fire hazards in storage and use.

Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and fully encapsulating suit. Barium may ignite itself if exposed to air. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Barium is stable at room temperature under special storage and handling conditions (Sec. 9). If the free metal is exposed to air, an explosion hazard exists because hydrogen is liberated. Barium compounds are more stable than elemental barium. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Barium reacts violently with water, carbon tetrachloride, trichloroethylene, fluorotrichloromethane, and tetrachloroethylene. This material is incompatible with acids, trichloroethylene and water, trichlorotrifluoroethane, 1,1,2-trichloro trifluoro ethane, and fluorotrichloroethane. Barium is extremely reactive and reacts readily with halogens and ammonia. Barium compounds are not as reactive as elemental barium. See MSDSs 40, 119, 132, 173, 181, and 251 for specific chemical incompatibilities.

Conditions to Avoid: Avoid heating barium in hydrogen to about 392 °F/200 °C since it reacts violently and forms barium hydride (BaH_2). An explosion hazard exists if the free metal is exposed to moist air or cold water because hydrogen is liberated.

Section 6. Health Hazard Data

Carcinogenicity: Although the NTP, IARC, and OSHA do not list barium as a carcinogen, the IARC lists barium chromate (VI) as a carcinogen.

Summary of Risks: Barium presents mainly an explosion hazard. However, soluble compounds of barium by the oral route are highly toxic and the fatal dose of the chloride has been stated to be 0.8 to 0.9 g. Death may occur from a few hours to a few days. The soluble barium compounds exert a profound effect on skeletal, arterial, intestinal, bronchial, and particularly cardiac muscle. Effects on the hematopoietic system for the formation of blood or blood cells in the living body and the cerebral cortex are also noted. Poisoning may also occur if the dust of soluble compounds is inhaled. Certain compounds of barium are irritants of the skin, eyes, and mucous membranes. Barium oxide and barium hydroxide, strongly alkaline in aqueous solution, cause severe skin irritation and burns of the eye. Inhalation of insoluble barium produces a benign pneumoconiosis (baritosis). The half-life of barium in bone has been estimated at 50 days.

Medical Conditions Aggravated by Long-Term Exposure: None reported.

Target Organs: Skin, eyes, mucous membranes, lung, heart.

Primary Entry Routes: Inhalation of dust or fume, ingestion, skin or eye contact.

Acute Effects: Systemic absorption from ingestion causes gastroenteritis (inflammation of the stomach lining and the intestines), slow pulse rate (heart may stop while contracting), muscle spasm, and hypokalemia (potassium deficiency in the blood). Inhalation causes coughing, bronchial irritation, and pneumoconiosis. Contact with soluble salts causes dermatitis, irritation of the eyes and mucous membranes, and burns. During radiological examination, intraperitoneal (in the abdomen) or intrathoracic (in the chest) barium sulfate contamination resulting from a complication rupture may cause a significant inflammatory response.

Chronic Effects: Although baritosis (caused by inhaling barium sulfate) produces nodular opacities on chest X-rays, there is no evidence of clinical illness or bodily dysfunction.

FIRST AID

Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.

Skin: Quickly remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have a conscious person drink 1 to 2 glasses of water, then induce vomiting.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Physician's Note: Consider using calcium gluconate for muscular spasms. Consider gastric lavage followed by saline catharsis if soluble barium compounds are ingested. Institute cardiac monitoring for all significant ingestions of soluble barium salts.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of spill. Immediately shut off all heat and ignition sources and evacuate hazard area. Cleanup personnel should protect against dust inhalation and contact with skin, eyes, and mucous membranes. For small dry spills, use a clean shovel to place material into a clean, dry container with a cover. For a large dry spill, cover with a plastic sheet to minimize spreading. For liquid spills, cover with sand or other noncombustible material and place in disposal containers. Follow applicable OSHA regulations (29 CFR 1910.120).

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations*

RCRA Hazardous Waste (40 CFR 261.33): Not listed

CERCLA Hazardous Substance (40 CFR 302.4): Not listed

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations *

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)

*Designations for barium only.

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.

Warning: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.

Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below OSHA PEL and ACGIH TLV (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.⁽¹⁰⁾

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store under inert gas, petroleum, or oxygen-free liquid in a cool, dry, well-ventilated area away from all incompatibles (Sec. 5).

Engineering Controls: Barium metal itself presents mainly an explosion hazard. All engineering systems should be of maximum explosion-proof design and electrically grounded and bonded. Use nonsparking tools. Proper storage is essential. Avoid dust inhalation and skin, eye, and mucous membrane contact. All processes should be enclosed and/or exhaust ventilation installed to keep the dust concentrations below the recommended levels. Practice good personal hygiene and housekeeping procedures. Preemployment and periodic medical examinations should be given to workers exposed to barite dust. Prevent exposing individuals with respiratory disorders.

Transportation Data (49 CFR 172.102)

IMO Shipping Name: Barium alloys, pyrophoric

IMO Hazard Class: 4.2

IMO Label: Spontaneously combustible

IMDG Packaging Group: II

ID No.: UN1854

MSDS Collection References: 7, 26, 38, 73, 85, 87, 89, 100, 103, 109, 123, 124, 126, 127, 133, 136, 138, 139

Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD

Material Safety Data Sheet

from Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855



GENIUM PUBLISHING CORP.

No. 23

CADMIUM

(Revision C)

Issued: September 1977

Revised: November 1988

SECTION 1. MATERIAL IDENTIFICATION

Material Name: CADMIUM

Description (Origin/Uses): Used in electroplating other metals; in dentistry; in alloys; in nickel-cadmium batteries; and in reactor control rods.

Other Designations: Cd; CAS No. 7440-43-9

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.



Genium

HMIS

H 3 R 1

F 1 I 4

R 0 S 1

PPG*

*See sect. 8 K 4 (Dust)

SECTION 2. INGREDIENTS AND HAZARDS, EXPOSURE LIMITS

Cadmium, CAS No. 7440-43-9, ca 100%

OSHA PEL

8-Hr TWA: 0.1 mg/m³ (Cd Fume)

Ceiling: 0.3 mg/m³ (Cd Fume)

8-Hr TWA: 0.2 mg/m³ (Cd Dust)

Ceiling: 0.6 mg/m³ (Cd Dust)

ACGIH NIC,* 1988-89

TLV-TWA: 0.01 mg/m³ (Cadmium and Compounds, as Cd)

ACGIH A2, Suspected Human Carcinogen

ACGIH TLVs, 1988-89

TLV-TWA: 0.05 mg/m³ (Cadmium Dusts and Salts, as Cd)

TLV-Ceiling: 0.05 mg/m³ (Cadmium Oxide Fume, as Cd)

TLV-TWA: 0.05 mg/m³ (Cadmium Oxide Production)

Toxicity Data**

Human, Inhalation, LC₅₀: 39 mg/m³ (20 Minutes)

*Notice of Intended Changes, Genium reference 116, p. 39.

**See NIOSH, RTECS (EU9800000), for additional data referring to reproductive, tumorigenic, and mutagenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 1413°F (767°C)

Melting Point: 610°F (321°C)

Vapor Pressure: 0.095 Torr at 610°F (321°C)

Molecular Weight: 112 Grams/Mole

Solubility in Water (%): Insoluble

Specific Gravity (H₂O = 1): 8.642

Appearance and Odor: A soft, blue white, malleable, lustrous metal that can be cut easily with a knife; odorless.

Comments: Cadmium has a significant vapor pressure of 0.000021 torr (corresponding to 0.12 mg/m³) at 315°F (157°C). Heating this metal without using correct engineering controls and/or personal protective equipment can result in overexposure.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method*

Autoignition Temperature*

LEL*

UEL*

Extinguishing Media: *Cadmium metal burns readily in air if it is heated. As with most metals, the reactivity/dust-cloud-explosion hazard increases as the cadmium metal becomes more finely divided. In fact, finely divided, powdered cadmium metal can be pyrophoric (it burns spontaneously in air without any source of ignition). Carbon dioxide, dry chemical, or sand are recommended extinguishing agents for cadmium fires. Unusual Fire or Explosion Hazards: Cadmium dust can explode during a fire. Massive cadmium metal does not present this potential explosion hazard; however, certain work operations such as grinding, welding, or cutting, can produce dust made of finely divided cadmium particles. Warning: Do not create a dust cloud of cadmium particles, especially during cutting, grinding, or welding operations. Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Stability/Polymerization: Cadmium is stable in closed containers during routine operations. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Cadmium reacts dangerously with ammonium nitrate, hydrazoic acid, tellurium, and zinc (Genium ref. 84).

Conditions to Avoid: Avoid all exposure to sources of ignition and to incompatible chemicals. Hazardous Products of Decomposition: When heated, which is likely during fires and work operations such as welding and machining, cadmium metal can decompose into cadmium metal fume and cadmium oxide fume.

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: The ACGIH classifies cadmium and its compounds as suspected human carcinogens (group A2); the IARC lists them as probable human carcinogens (group 2B); and the NTP classifies them as anticipated human carcinogens (group b). Summary of Risks: Heating cadmium metal produces intensely irritating cadmium metal fume. The acute effects of its excessive inhalation, which include severe tracheobronchitis, pneumonitis, and pulmonary edema, are life threatening and are usually delayed for several hours; their mortality rate is about 20%. Nonfatal pneumonitis has resulted from exposure to 0.5 to 2.5 mg/m³; a fatality has been reported for five hours' exposure at 9 mg/m³ and for 1 hour's exposure at 40 to 50 mg/m³. There is no warning discomfort or immediate irritation from exposure to cadmium fume. Acute gastroenteritis and symptoms of metal fume fever are associated with even lower acute exposure. Symptoms of acute overexposure include excessive salivation, a dry, burning throat; headache; aching muscles; coughing; chest tightness and pain; nausea; chills, and fever chills; and fever. Medical Conditions Aggravated by Long-Term Exposure: None reported. Target Organs: Skin, eyes, respiratory system, kidneys, and blood. Primary Entry: Inhalation, skin contact. Acute Effects: See Summary of Risks, above. Chronic Effects: Long-term, chronic inhalation of cadmium dust, salts, or fume causes chronic cadmium poisoning characterized by a distinctive, nonhypertrophic emphysema with or without renal tubular injury, accompanied by the urinary excretion of a protein with a molecular weight

SECTION 6. HEALTH HAZARD INFORMATION, cont.

of 20,000 to 30,000. This protein is itself a sign of early but reversible chronic poisoning. (Possible chromosomal aberrations and decreased birth weight among babies of women exposed to cadmium have been noted.) **Danger:** Continued overexposure from inhalation causes irreversible renal tubular damage. Cancer, anemia, eosinophilia, anosmia, chronic rhinitis, yellowed teeth, and bone changes have been reported. Bone pain in the ribs, backbone, and femur is common; disorders of calcium metabolism develop; and kidney stones and pulmonary fibrosis have been described. **FIRST AID:** **Eyes.** Immediately flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 minutes. **Skin.** Rinse the affected area with flooding amounts of water, then wash it with soap and water. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. **Ingestion.** If a physician is not readily available, give the exposed person 2 to 3 glasses of water to drink and induce vomiting. A physician may administer a gastric lavage followed by saline catharsis. **Comments:** A comprehensive medical program is advised for those who work with cadmium or its compounds. This should include chest X rays and forced-vital-capacity tests. Get medical help (in plant, paramedic, community) for all exposures. Seek prompt medical assistance for further treatment, observation, and support after first aid. **Note to Physician:** Chelation therapy may be useful in treatment; calcium disodium edetate and penicillamine are recommended. Dimercaprol (BAL) is not recommended because of reported renal toxicity of the cadmium-BAL complex.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate unnecessary personnel, eliminate all sources of ignition immediately, and provide adequate ventilation. Cleanup procedures must not create dusty conditions. Pick up the spilled material using vacuuming, mopping, or wet-sweeping techniques. Cleanup personnel need protection against inhalation of dust and fume (see sect. 8). **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations. Concentrated solutions of cadmium waste can be precipitated with lime and collected by filtration. Effluent should be treated as needed to reduce the concentration of the cadmium to a level that is within regulatory compliance limits.

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).

EPA Designations (40 CFR 302.4)

RCRA Hazardous Waste, No. D006 (40 CFR 261.24 [Characteristic of EP toxicity])

CERCLA Hazardous Substance, Reportable Quantity: 1 lb (0.454 kg), per the Clean Water Act (CWA), § 307 (a).

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing of a cadmium solution is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Use a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets, to prevent prolonged or repeated skin contact with this material. **Ventilation:** Install and operate general and local maximum explosion-proof ventilation systems powerful enough to maintain airborne levels of cadmium below the OSHA PEL cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from your shoes and equipment. Do not wear work clothes home. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale cadmium fume. Do not expose individuals with lung, liver, kidney, and blood ailments to cadmium until such exposure is approved by a physician.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store cadmium in closed containers in a cool, dry, well-ventilated area away from sources of ignition and strong oxidizers. Protect containers from physical damage. Avoid storage situations where corrosion can occur. Keep powdered cadmium in closed containers; prevent the airborne dispersion of powdered cadmium. **Engineering Controls:** Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. Ground and bond all containers, pipelines, etc., used in shipping, transferring, reacting, producing, and sampling operations to prevent static sparks. **Other Precautions:** The toxic effects of cadmium are influenced by the presence or absence of other elements such as zinc and selenium. If these materials are present in the workplace, careful evaluation of any exposure to cadmium is required to understand any contributing factors.

Hazardous Materials Table (49 CFR 172.101): Not Listed

Optional Hazardous Materials Table (49 CFR 172.102)

ID No. UN2570

IMO Shipping Name: Cadmium Compounds

IMO Hazard Class: 6.1

IMO Labels: Poison or Saint Andrew's Cross (X)*

*Harmful—Stow away from Foodstuffs (IMO Label, Materials of Class 6.1 Packaging Group III).

References: 1, 26, 38, 84-94, 100, 116, 117, 120, 122.

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Prepared by PJ Igoe, BS

Industrial Hygiene Review: DJ Wilson, CIH

Medical Review: W Silverman, MD

MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION

1145 CATALYN ST., SCHENECTADY, NY 12303 USA (518) 377-8854



MSDS # 162

COPPER (SCRAP - GENERIC)

Issued: December 1985

Revised:

From Genium's MSDS Collection, to be used as a reference.

SECTION 1. MATERIAL IDENTIFICATION

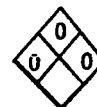
18

MATERIAL NAME: COPPER (SCRAP-GENERIC)

OTHER DESIGNATIONS: Copper (Cu) Metal, Casting, or Powder Scrap

DESCRIPTION: Copper or Copper Alloy.

MANUFACTURER: Available from several suppliers.



R 1
I 3
S 1
K 0

SECTION 2. INGREDIENTS AND HAZARDS

BASE METAL: Copper (Cu) CAS #7440 50 8

%
100%
maximum

HAZARD DATA

*PEL (OSHA): 0.1 mg/m³
**TLV (ACGIH): 0.2 mg/m³
(as copper fume)

*PEL (ACGIH): 1.0 mg/m³
**TLV (ACGIH): 1.0 mg/m³
(as copper dust or mist)

Rat, oral TDLo:

152 mg/kg

Human, oral TDLo:

120 mg/kg

* OSHA Permissible Exposure Limit (PEL)

** American Conference of Governmental Industrial Hygienists (ACGIH)
Threshold Limit Values (TLV's) current as of revision date.

SECTION 3. PHYSICAL DATA

Boiling Point @ 1 atm ~2500°C

Vapor Pressure @ 20°C (mm Hg) ... N/A

% Volatile by Volume N/A

Melting Point Approx. 1100°C

Solubility in Water Insoluble

Evaporation Rate (BuAc=1) ... N/A

APPEARANCE & ODOR: Solid, various shapes, odorless, red/brown-colored metal or powder.

SECTION 4. FIRE AND EXPLOSION DATA

Lower

Upper

Flash Point and Method

Autoignition Temp.

Flammability Limits in Air

None

None

None

NA

NA

EXTINGUISHING MEDIA: Will not burn. Use water to cool.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Fine metal particles produced when ground, sawed, etc., can burn. High concentration of fines (fine particles) in the air may present an explosion hazard. Good housekeeping and adequate ventilation is recommended. Use air-supplied or self-contained breathing apparatus if fires are in enclosed areas.

SECTION 5. REACTIVITY DATA

This material is stable under most conditions. No hazardous polymerization or explosion conditions exist for the bulk metal.

INCOMPATIBILITIES: Strong acids

DECOMPOSITION PRODUCTS: Metallic oxides (copper fumes)

SECTION 6. HEALTH HAZARD INFORMATION

TLV

See Section 2

Copper scrap is poorly absorbed through the skin or alimentary tract, and while in the solid state it is not considered a hazard. Operations such as welding, dust generation, or fume generation could allow exposure to copper dusts and fumes. Therefore, it is important to maintain exposure levels below the regulated levels as noted in Section 2. Determine actual exposures by industrial hygiene monitoring.

Short-term exposure to copper dusts or fumes may cause irritation of the upper respiratory tract and "metal fume fever," a transient condition with symptoms of fever and chills. Chronic or long-term exposure may result in lung X-ray changes not associated with harmful effects.

FIRST AID:

EYE CONTACT: Protect eyes from particles or fumes. Wash exposed eyes with copious amounts of water for at least 15 minutes.

SKIN CONTACT: Protect skin from molten metal and radiant heat when melting scrap. Skin contamination from powder may be cleaned with soap and water. Machine turnings may present a laceration hazard.

INHALATION: Move to fresh air, restore or support breathing as required.

INGESTION: NA

Copper has not been identified as a carcinogen by NTP, IARC or OSHA.

SECTION 7. SPILL, LEAK AND DISPOSAL PROCEDURES

Copper scrap is normally recycled or sold as scrap or landfilled if recycling cannot be justified. Clean up dust/powder spills promptly by vacuum and wet cleaning methods. Treat as an inert solid. Dispose of in accordance with OSHA, EPA, state, or local regulations.

SECTION 8. SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION: Use NIOSH/MSHA-approved dust/fume respirator or air-supplied respirator if concentrations of copper in air exceed the regulated standards. Use air-supplied or self-contained breathing apparatus (SCBA) in confined spaces.

VENTILATION: Use only with adequate ventilation where respirable dusts/mists/fumes are possible. Use local exhaust ventilation when cutting, grinding, welding, or remelting.

EYE PROTECTION AND PROTECTIVE CLOTHING: Protect skin from cuts and from hot procedures and processes. Eye and face protection required when grinding, welding, cutting or remelting. Maintain good hygiene and safe work processes. Scrap from machining may be contaminated with cutting oils. When handling oil-contaminated copper, wear rubber gloves to prevent skin contact.

Contact lenses pose a special hazard; soft lenses may absorb and all lenses concentrate irritants.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Always maintain exposures below the PEL/TLV. Use industrial hygiene air monitoring to ensure that your use of this material does not create a hazard. Always use exhaust ventilation when feasible.

DATA SOURCE(S) CODE (See Glossary) 1-12, 14, 19, 20, 30, 31, 40, 59, OW

Judgements as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

APPROVALS JOR Dec 1, 1985, 31486.

INDUST. HYGIENE/SAFETY JH 1-86

MEDICAL REVIEW: JH Mar 86



Genium Publishing Corporation

1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 83
Chromium Metal/Powder

Issued: 3/81

Revision: A, 11/89

Section 1. Material Identification

30

Chromium Metal/Powder Description: Obtained from chrome ore, chromite (FeCr_2O_4), by electrolysis of chromium solutions, by direct reduction (ferrochrome), and by reducing the oxide with finely divided carbon or aluminum. Used for chromeplating other metals; for greatly increasing metal resistance and durability; in manufacturing chrome-steel or chrome-nickel-steel alloys (stainless steel); as a constituent of inorganic pigments; as protective coating for automotive and equipment accessories; and in nuclear and high-temperature research.

Other Designations: Chrome; Cr; CAS No. 7440-47-3.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.

R 1
I 4
S 1
K 1

Genium



HMIS
H 2
F 1
R 1
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Chromium metal/powder, ca 100%

OSHA PEL

ACGIH TLV, 1988-89*

NIOSH REL, 1987†

Toxicity Data‡

8-hr TWA: 1 mg/m³

TLV-TWA: 0.5 mg/m³

8-hr TWA (for chromium metal
and insoluble salts): 1 mg Cr/m³

Rat, implant, TD₀₁: 1200 µg/kg body weight
administered intermittently over six weeks

* This TLV is applicable to Cr³⁺ and Cr⁶⁺ compounds. For water soluble and water-insoluble Cr⁶⁺, the 8-hr TWA is 0.05 mg Cr⁶⁺/m³. Certain water-insoluble Cr⁶⁺ compounds (zinc chromate, calcium chromate, lead chromate, barium chromate, strontium chromate, and sintered chromium trioxide) are designated as A1a (human carcinogen).

† The NIOSH REL (10-hr TWA) for carcinogen Cr⁶⁺ compounds is 1 µg/m³; for noncarcinogenic Cr⁶⁺ compounds (including chromic acid), the RELs (10-hr TWAs) are 25 µg/m³ and 50 µg/m³ (15-min ceiling). The noncarcinogenic compounds include mono- and dichromates of hydrogen, cesium, sodium, lithium, potassium, rubidium, ammonia, and Cr⁶⁺ (chromic acid anhydride). Any and all Cr⁶⁺ materials excluded from the noncarcinogenic group above are carcinogenic Cr⁶⁺ compounds.

‡ See NIOSH, RTECS (GB4200000), for additional data with references to tumorigenic effects.

Section 3. Physical Data

Boiling Point: 4788 °F (2642 °C)

Atomic Weight: 51.996 g/mol

Melting Point: 3452 °F (1900 °C)

Specific Gravity (H₂O = 1 at 39 °F (4 °C)): 7.2 at 68 °F (20 °C)

Vapor Pressure: 1 mm Hg at 2941 °F (1616 °C)

Water Solubility: Insoluble

Vapor Density (Air = 1): 1.79

Appearance and Odor: Steel-gray, lustrous metal; no odor.

Section 4. Fire and Explosion Data

Flash Point: None reported

Autoignition Temperature: Cloud, 1076 °F (580 °C); dust
layer, 752 °F (400 °C)

LEL: Dust cloud explosion,
0.230 oz/ft³

UEL: None reported

Extinguishing Media: Use dry chemical or sand.

Unusual Fire or Explosion Hazards: Particle size and dispersion in air determine reactivity. Chromium powder explodes spontaneously in air, while chromium dust suspended in CO₂ is ignitable and explosive when heated.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

*One hundred percent of dust goes through a 74-µm sieve. A 140-mJ spark can ignite a dust cloud.

Section 5. Reactivity Data

Stability/Polymerization: Chromium is stable when properly handled and stored. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Chromium reacts readily with dilute, not nitric, acids to form chromous salts. It is soluble in acids (not nitric) and strong alkalis. Its powder is incompatible with strong oxidizing agents, including high O₂ concentration. Evaporation of mercury (Hg) from Cr amalgam leaves pyrophoric chromium. Finely divided Cr attains incandescence with nitrogen oxide, potassium chlorate, and sulfur dioxide. Molten lithium at 18 °C severely attacks Cr. Fused ammonium nitrate below 200 °C reacts explosively and may ignite or react violently with bromine pentafluoride.

Hazardous Products of Decomposition: Thermal oxidative decomposition of Cr can produce toxic chromium oxide fumes.

Section 6. Health Hazard Data

Carcinogenicity: The NTP and OSHA list chromium as a human carcinogen.

Summary of Risks: When ingested chromium is a human poison, with gastrointestinal (GI) effects. Chromium 3 (Cr^{+3}) compounds show little or no toxicity. Less soluble chromium 6 (Cr^{+6}) compounds are suspected carcinogens and severe irritants of the larynx, nasopharynx, lungs, and skin (Sec. 2). Chromic acid or chromate salts cause irritation of the skin and respiratory passage. Ingestion leads to severe irritation of the gastrointestinal tract, renal damage, and circulatory shock. Chromium metal (when heated to high temperatures) and insoluble salts are said to be involved in histological fibrosis of the lungs, which may progress to clinically evident pneumoconiosis. Exposure to chromate dust and powder can cause skin (dermatitis) and eye irritation (conjunctivitis).

Medical Conditions Aggravated by Long-Term Exposure: An increased incidence of bronchogenic carcinoma occurs in workers exposed to chromate dust.

Target Organs: Respiratory system.

Primary Entry: Inhalation, percutaneous absorption, and ingestion.

Acute Effects: Acute exposures to dust may cause headache, coughing, shortness of breath, pneumoconiosis, fever, weight loss, nasal irritation, inflammation of the conjunctiva, and dermatitis.

Chronic Effects: Asthmatic bronchitis.

FIRST AID

Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.

Skin: Brush off chromium dust. After rinsing affected area with flooding amounts of water, wash it with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that conscious person slowly drink 1 to 2 glasses of water to dilute. Do not induce vomiting. A physician should evaluate all ingestion cases.

After first aid, get appropriate in-plant, paramedic, or community medical attention and support.

Physician's Note: Acute toxicity causes a two-phase insult: 1) multisystem shock due to gastrointestinal corrosivity and 2) hepatic, renal, hematopoietic insult. Treatment should use ascorbic acid as a neutralizer with gastric lavage. If the ingestion is substantial, exchange transfusions and/or consider hemodialysis. Treat allergic dermatitis with local cortisone or 10% ascorbic acid to reduce Cr^{+6} to Cr^{+3} . Ten percent EDTA in a lanolin base applied every 24 hr helps heal skin ulcers.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of large spills. Cleanup personnel should wear protective clothing and approved respirators. Remove heat and ignition sources. Provide adequate ventilation. Keep airborne dust at a minimum. Remove spills quickly and place in appropriate containers for disposal or reuse.

Disposal: Reclaim salvageable metal. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per Clean Water Act, Sec. 307(a)]

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Wear a NIOSH-approved respirator if necessary. Wear an SCBA with a full facepiece when the particle concentration's upper limit is 50 mg/m^3 .

Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.

Other: Wear impervious rubber gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.

Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA standard (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103).

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store material in cool, dry, well-ventilated area separate from acids and oxidizing agents. Seal and protect containers from physical damage. Keep away from heat or ignition sources.

Engineering Controls: Avoid dust inhalation. Practice good housekeeping (vacuuming and wet sweeping) to minimize airborne particulates and to prevent dust accumulation. Use nonsparking tools and ground electrical equipment and machinery.

Transportation Data (49 CFR 172.101, .102): Not listed

MSDS Collection References: 1, 2, 26, 38, 80, 87, 88, 89, 100, 109, 124, 126

Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD

M2

Potential Exposure: Used as an androgenic, anabolic and estrogenic hormone for both males and females.

Permissible Exposure Limits in Air: The USSR-UNEP/IRPTC project (43) has set an MAC in workplace air of 0.005 mg/m³ (5 µg/m³).

Permissible Concentration in Water: No criteria set.

Harmful Effects and Symptoms: Testosterone can affect you when breathed in and by passing through your skin. Testosterone is a teratogen—handle with extreme caution. Exposure can cause nausea, acne and fluid build-up in body tissues. Women can also develop male features, baldness, increased body hair, deep voice and menstrual changes. Men can have lower sperm production, breast changes and enlarged prostate. If carried home (clothing, etc.) children in the home may have stunted growth, premature puberty in boys and abnormal genitals in girls.

Medical Surveillance: Frequent exams (at least monthly) are recommended to evaluate for any signs or symptoms of exposure. If exposure is suspected, the following are recommended: Red blood cell count (in men). Urine test for androsterone and/or etiocholanolone. (The more common 17-keto steroid test is not sufficiently sensitive for such exposures.)

First Aid: Eye Contact — Immediately remove any contact lenses and flush with large amounts of water for at least 15 minutes, occasionally lifting upper and lower lids.

Skin Contact — Quickly remove contaminated clothing. Immediately wash contaminated skin with large amounts of water.

Personal Protective Methods: Clothing — Avoid skin contact with testosterone. Wear protective gloves and clothing. Safety equipment suppliers/manufacturers can provide recommendations on the most protective glove/clothing material for your operation. All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work.

Eye Protection — Wear dust-proof goggles when working with powders or dust, unless full facepiece respiratory protection is worn.

Respirator Selection: Where the potential exists for exposure to testosterone, use a MSHA/NIOSH approved supplied-air respirator with a full facepiece operated in the positive pressure mode or with a full facepiece, hood, or helmet in the continuous flow mode, or use a MSHA/NIOSH approved self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.

Storage: Store in tightly closed containers in a cool, well-ventilated area.

Spill Handling: Restrict persons not wearing protective equipment from area of spill or leak until clean-up is complete. Collect powdered material in the most convenient and safe manner and deposit in sealed containers.

Fire Extinguishing: Testosterone may burn, but does not readily ignite. Use dry chemical, CO₂, water spray, or foam extinguishers.

References

- Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 3, 81-82 (1981).
New Jersey Department of Health, "Hazardous Substance Fact Sheet: Testosterone," Trenton, NJ (Feb. 17, 1987).

TETRABROMOETHANE

See "Acetylene Tetrabromide."

TETRACHLORODIBENZO-p-DIOXIN

- ## Carcinogen (Animal Positive) (NTP) (NCI) (9) (DFG) (3)
- ## Banned or Severely Restricted (Finland) (UN) (13)
- ## Very Toxic Substance (World Bank) (15)

- ## Air Pollutant Standard Set (Several States) (60)
- ## Water Pollution Standard Proposed (EPA) (6) (Maine, Minnesota) (61)
- ## Hazardous Substance (EPA) (RQ = 1.0/0.454) (4)
- ## Priority Toxic Pollutant (EPA) (6)
- ## Cited in U.S. State Regulations: California (G), Florida (G), Illinois (G), Indiana (A), Maine (G,W), Massachusetts (G,A), Minnesota (W), New Hampshire (G), New York (G), North Carolina (A), North Dakota (A), Oklahoma (G), Pennsylvania (A), Rhode Island (G), South Carolina (A), Virginia (A), West Virginia (G)

Description: Polychlorinated dibenzo-p-dioxins are formed in the manufacturing process of all chlorophenols. However, the amount formed is dependent on the degree to which the temperature and pressure are controlled during production. An especially toxic dioxin, 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), is formed during the production of 2,4,5-TCP (trichlorophenol) by the alkaline hydrolysis of 1,2,4,5-tetrachlorobenzene. Tetrachlorodibenzo-p-dioxin has the formula $C_{12}H_4Cl_4O_2$. TCDD is a white crystalline solid with a melting point range of 302° to 305° C. Decomposition begins at 500°C and is virtually complete within 21 seconds at a temperature of 800°C.

Code Numbers: CAS 1746-01-6 RTECS HP3500000

Synonym: TCDD.

Potential Exposures: TCDD has no uses as such. As noted above, TCDD is an inadvertent contaminant in herbicide precursors and thus in the herbicides themselves. Thus, it is applied in herbicide formulations, but is not used per se. It has been estimated that approximately 2 million acres in the United States have been treated for weed control on one or more occasions with approximately 15 million pounds of TCDD contaminated 2,4,5-T, 2,4-D, or combinations of the two.

Permissible Exposure Limits in Air: There are no numerical limits set by major governmental agencies; in view of its effects, all contact should be avoided. A number of states however, have set guidelines or standards for TCDD in ambient air (60) ranging from zero (North Dakota and South Carolina) to 1.1 picograms/m³ (Massachusetts) to 0.003 nanogram/m³ (North Carolina) to 0.0001 µg/m³ (Pennsylvania) to 3.0 µg/m³ (Virginia) to 450.0 µg/m³ (Indiana).

Permissible Concentration in Water: There are insufficient data to permit the development of criteria for the protection of freshwater or saltwater aquatic life. For the protection of human health, the concentration is preferably zero. An additional lifetime cancer risk of 1 in 100,000 is posed at a concentration of 4.55×10^{-7} µg/l as of 1979. A concentration of 0.0039 ng/l was estimated to limit cancer risk to one in a million by EPA in 1980. States which have set guidelines for TCDD in drinking water include Maine at 2×10^{-4} µg/l and Minnesota at 2×10^{-6} µg/l (61).

Determination in Water: Methylene chloride extraction followed by transfer to benzene and capillary column gas chromatography/mass spectrometry with electron impact ionization (EPA Method 613) or gas chromatography plus mass spectrometry (EPA Method 625).

Routes of Entry: Skin absorption, inhalation of vapors.

Harmful Effects and Symptoms: Short Term Exposure: *Note* — 2,3,7,8-TCDD is one of the most toxic synthetic chemicals.

Inhalation — Can cause burning sensation in nose and throat, headache, dizziness, nausea, vomiting, pain in the joints, tiredness, emotional disorders, blurred vision and muscle pain, nervousness, irritability and intolerance to cold. Itching, swelling and redness followed by acne-like eruptions of the skin known as chloracne commonly occur. Symptoms of chloracne may appear weeks or months after initial exposure and may last a few months or up to 15 years. Can cause abnormalities of liver, pancreas, circulatory system and respiratory system and death.

Skin — Contact with very small amounts can cause chloracne.

Eyes — Can cause burning and irritation.

Ingestion — Can cause effects described under inhalation. Animal studies suggest that daily exposure to amounts smaller than one grain of salt may cause severe symptoms and death within a few weeks.

Long Term Exposure — Can cause effects under inhalation, especially chloracne, as well as numbness and tingling in arms and legs. A blood abnormality may occur which may include light sensitive skin, blisters, dark skin coloration, excessive hair growth and dark red urine. Reproductive

problem
because

prepara
sure ca

inate
and w

moni

able
glove

to lin
ing a

ware
mani

place
water

Refe
U.S.

U.S.

U.S.

Sax,
Nat.

New

##

##

1,1
40

problems and an increased susceptibility to infection may occur. TCDD is considered a carcinogen because extremely low levels cause cancer and birth defects in animals.

Medical Surveillance: In short, contact with TCDD should be avoided but obviously careful preplacement and regular physical exams should be carried out in those cases where workers exposure cannot be avoided with emphasis on liver and kidney function studies.

First Aid: *Inhalation* — Remove from exposure. Seek medical attention immediately.

Skin — Remove chemically soiled clothing immediately, taking precautions not to contaminate skin or other articles. Immediately wash exposed skin vigorously and repeatedly with soap and water. Seek medical attention immediately.

Eyes — Wash with running water for at least 15 minutes. Seek medical attention immediately.

Ingestion — Seek medical attention immediately.

Note to Physician — Liver and nerve function screening tests should be performed. Also monitor serum triglycerides and cholesterol.

Personal Protective Methods: Wear safety glasses and disposable plastic gloves and disposable apron or lab coat. Workers should be trained in proper method of removing contaminated gloves and clothing without contacting exterior surfaces.

Respirator Selection: Should be used in ventilated hood. Every precaution should be taken to limit airborne concentration. In case of spill, a supplied-air respirator or a self-contained breathing apparatus with full facepiece should be worn.

Storage: Use in isolated area with adequate ventilation, preferably a hood, segregated glassware and tools, and plastic backed absorbent. Thoroughly wash hands and forearms after each manipulation and before leaving work area. Use the same precautions required for radioactive work.

Spill Handling: Warn other workers of spill. Wearing protective clothing, absorb spill and place in a suitable container. Rinse area with 1,1,1-trichloroethane, then wash with detergent and water.

References

- U.S. Environmental Protection Agency, *2,3,7,8-Tetrachlorodibenzo-p-Dioxin: Ambient Water Quality Criteria*, Washington, DC (1979).
- U.S. Public Health Service, "Toxicological Profile for 2,3,7,8-Tetrachloro-Dibenzo-p-Dioxin," Atlanta, Georgia, Agency for Toxic Substances & Disease Registry (Nov. 1987).
- U.S. Environmental Protection Agency, *TCDD*, Health and Environmental Effects Profile No. 155, Washington, DC, Office of Solid Waste (April 30, 1980).
- Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report*, 1, No. 2, 63-64 (1980).
- Nat. Inst. for Occupational Safety & Health, *2,3,7,8-Tetrachlorodibenzo-p-dioxin*, Current Intelligence Bulletin 40, DHHS (NIOSH) Publication No. 84-104, Cincinnati, Ohio (Jan. 23, 1984).
- New York State Department of Health, "Chemical Fact Sheet: 2,3,7,8-TCDD (Dioxin)," Albany, NY, Bureau of Toxic Substance Assessment (March 1986).

TETRACHLORODIFLUOROETHANES

- ## Air Pollutant Standard Set (ACGIH) (1) (DFG) (3) (HSE) (33) (OSHA) (58) (USSR) (43) (Several States) (60)
- ## Cited in U.S. State Regulations: Alaska (G), Connecticut (A), Florida (G), Illinois (G), Maine (G), Massachusetts (G,A), Nevada (A), New Hampshire (G), New Jersey (G), North Carolina (A), North Dakota (A), Pennsylvania (G), Rhode Island (G), Virginia (A), West Virginia (G)

Description: $\text{CCl}_2\text{FCCl}_2\text{F}$, 1,1,2,2-tetrachloro-1,2-difluoroethane, and also $\text{CCl}_3\text{CF}_2\text{Cl}$, 1,1,1,2-tetrachloro-2,2-difluoroethane are both colorless liquids or solids melting at 26°C and 40° to 41°C respectively. They have a slight etherlike odor.

Code Numbers:

1,1,2,2-T-1,2-D	CAS 76-12-0	K11420000
1,1,1,2-T-2,2-D	CAS 76-11-9	K11425000

Hazardous Substance Database

Topic: 2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN

SUBSTANCE IDENTIFICATION

Name of Substance:

1. 2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN

CAS Registry Number:

1. 1746-01-6

Synonyms:

- 2,3,7,8-Tetrachlorodibenzo(b,e)(1,4)dioxin
- 2,3,7,8-Tetrachlorodibenzo-1,4-dioxin
- 2,3,7,8-Tetrachlorodibenzo-p-dioxin
- Dibenzo(b,e)(1,4)dioxin, 2,3,7,8-tetrachloro-
- Dibenzo-p-dioxin, 2,3,7,8-tetrachloro-

Dioxin

Dioxine

2,3,7,8-TCDD

RTECS Number:

1. NIOSH/HP3500000

CHEMICAL & PHYSICAL PROPERTIES

Color/Form:

1. COLORLESS NEEDLES

Melting Point:

1. 305-306 DEG C

Molecular Weight:

1. 322

Octanol/Water Partition Coefficient:

1. Log Kow = 7.02

Solubilities:

1. 1.4 G/L IN ORTHO-DICHLOROBENZENE
2. 0.72 G/L IN CHLOROBENZENE
3. 0.57 G/L IN BENZENE
4. 0.37 G/L IN CHLOROFORM
5. 0.11 G/L IN ACETONE
6. 0.05 G/L IN N-OCTANOL
7. 0.01 G/L IN METHANOL
8. 2×10^{-7} G/L IN WATER
9. 0.04 G/L IN LARD OIL
10. ... Water solubility of 19.3 ng/l

Vapor Pressure:

1. 7.4×10^{-10} mm Hg at 25 deg C

Other Chemical/Physical Properties:

1. TCDD CAN BE FORMED BY PYROLYSIS AT 500 DEG C FOR 5 HR OF SODIUM ALPHA-(2,4,5-TRICHLOROPHENOXY)PROPIONATE.

SAFETY & HANDLING

Hazardous Reactions

Decomposition:

1. /2,3,7,8-Tetrachlorodibenzo-p-dioxin/ begins to decompose at 500 deg C and virtually complete decomposition occurs within 21 seconds at a temp of 800 deg C.

Warning Properties

Skin, Eye, and Respiratory Irritations:

1. Acute exposure to 2,3,7,8-tetrachlorodibenzo-p-dioxin results in ... irritation of the eyes, skin, and respiratory tract.

Preventive Measures

Protective Equipment and Clothing:

- 1 For workers engaged in the decontamination process after an accident, it is recommended that they wear complete throw away equipment to protect the skin and prevent exposure to dust and vapors from the contaminated materials. A gas mask should be used if any procedure that may produce inhalation of airborne contaminated material cannot be avoided.
- 2 PRECAUTIONS FOR "CARCINOGENS": ... dispensers of liquid detergent /should be available./ ... Safety pipettes should be used for all pipetting. ... In animal laboratory, personnel should ... wear protective suits (preferably disposable, one-piece & close-fitting at ankles & wrists), gloves, hair covering & overshoes. ... In chemical laboratory, gloves & gowns should always be worn ... however, gloves should not be assumed to provide full protection. Carefully fitted masks or respirators may be necessary when working with particulates or gases, & disposable plastic aprons might provide addnl protection.... gowns ... /should be/ of distinctive color, this is a reminder that they are not to be worn outside the laboratory. /Chemical Carcinogens/

Other Protective Measures:

- 1 In case of an accident, that is if the process of synthesis of 2,4,5-trichlorophenol is running out of control and high levels of TCDD are present, contaminated clothing should be immediately removed, avoiding contamination of the skin or other parts of the body. Exposed parts should be washed immediately and repeatedly until medical attention is obtained.
- 2 PRECAUTIONS FOR "CARCINOGENS": Smoking, drinking, eating, storage of food or of food & beverage containers or utensils, & the application of cosmetics should be prohibited in any laboratory. All personnel should remove gloves, if worn, after completion of procedures in which carcinogens have been used. They should ... wash ... hands, preferably using dispensers of liq detergent, & rinse ... thoroughly. Consideration should be given to appropriate methods for cleaning the skin, depending on nature of the contaminant. No standard procedure can be recommended, but the use of organic solvents should be avoided. Safety pipettes should be used for all pipetting.

Cleanup Methods:

- 1 PRECAUTIONS FOR "CARCINOGENS": A high-efficiency particulate arrestor (HEPA) or charcoal filters can be used to minimize amt of carcinogen in exhausted air ventilated safety cabinets, lab hoods, glove boxes or animal rooms ... Filter housing that is designed so that used filters can be transferred into plastic bag without contaminating maintenance staff is avail commercially. Filters should be placed in plastic bags immediately after removal ... The plastic bag should be sealed immediately ... The

sealed bag should be labelled properly ... Waste liquids ... should be placed or collected in proper containers for disposal. The lid should be secured & the bottles properly labelled. Once filled, bottles should be placed in plastic bag, so that outer surface ... is not contaminated ... The plastic bag should also be sealed & labelled. ... Broken glassware ... should be decontaminated by solvent extraction, by chemical destruction, or in specially designed incinerators.

Disposal Methods:

- 1 SRP: At the time of review, criteria for land treatment or burial (sanitary landfill) disposal practices are subject to significant revision. Prior to implementing land disposal of waste residue (including waste sludge), consult with environmental regulatory agencies for guidance on acceptable disposal practices.
2. Disposing of wastes and residues containing tetrachlorodibenzo-p-dioxin (TCDD). ... Incineration on land: Basically such a system includes a large material handling building, tanks for storage of waste materials, a large rotary kiln with combustion chamber, high energy scrubber for control of air pollution, waste water treatment facilities and the necessary accessory equipment. A burner at the front of the rotating kiln burns the wastes pumped from the tank to maintain a minimum temperature of 800-1200 deg C. The material has to be exposed to that temperature for times exceeding 30 seconds.
- 3 Degradation by chemical means are necessary for polychlorophenol formulations because heat stable chlorodioxins are formed during incineration. Ruthenium tetroxide is a powerful oxidizing agent which reacts with a wide range of organic substances, incl those aromatic compounds which are oxidized slowly, or not at all, by permanganate. It may be safely used in soln in water or in organic solvents with no nucleophilic character, such as chloroform, nitromethane or carbon tetrachloride. Studies show that ruthenium tetroxide can be used for detoxification of glassware & artifacts, & for the periodic purging of industrial reactors to counteract the accumulation of polychloro-p-dioxin residues. Preliminary work with tetrachlorodibenzo-p-dioxin (TCDD) showed that the rate of oxidation was increased at higher temp & that the half-life was less than 15 min in carbon tetrachloride at 70 deg C (TCDD concn = 72 ug/ml CCl₄; ruthenium tetroxide = 2×10^{-3} ug/ml, about 10 equiv). There is no evidence of the nature of fragments formed during oxidation of the polychlorodibenzodioxins. However, the related chlorophenols undergo extensive decomposition to yield chlorine ions & no significant levels of organic products.

TOXICITY/BIOMEDICAL EFFECTS

Summary

Toxic Hazard Rating:

1. Classification of carcinogenicity: 1) evidence in humans: inadequate; 2) evidence in animals: sufficient. Overall summary evaluation of carcinogenic risk to humans is Group 2B; the agent is possibly carcinogenic to humans. /From table/

Toxicity Excerpts

Human Toxicity Excerpts:

76 CASES OF CHLORACNE /IN WORKERS ARE REPORTED/FOLLOWING EXPOSURE TO TETRACHLORODIBENZO-P-DIOXIN (TCDD) BETWEEN 1965-1968 IN FACTORY /PRODUCING 2,4,5-T & PENTACHLOROPHENOL/ IN CZECHOSLOVAKIA ... FIFTY-FIVE PATIENTS WERE SUBMITTED TO

MEDICAL FOLLOW UPS FOR OVER 5 YEARS; SOME HAD SYMPTOMS OF PORPHYRIA CUTANEA TARDA, UROPORPHYRINURIA, ABNORMAL LIVER TESTS ... & LIVER ENLARGEMENT. THE MAJORITY ... SUFFERED ... SEVERE NEURASTHENIA & DEPRESSIVE SYNDROME. IN 17 SUBJECTS, SIGNS OF PERIPHERAL NEUROPATHY, ESPECIALLY IN LOWER EXTREMITIES, WERE CONFIRMED ... MORE THAN HALF OF THE PATIENTS SHOWED RAISED LEVELS OF BLOOD CHOLESTEROL & TOTAL LIPIDS v

AN INCR IN NUMBER OF PERSONS WITH PRIMARY LIVER CANCER/IS REPORTED/ IN PROP TO ALL CANCER PT ADMITTED TO HANOI HOSPITALS DURING ... 1962-1968 (791 LIVER CANCER CASES OUT OF 7911 TOTAL CANCER CASES, 10%) AS COMPARED TO PERIOD OF 1955-1961 (159 LIVER CANCER CASES OUT OF 5492 CANCER CASES, 2.9%) WHICH WAS PRIOR TO THE START OF HERBICIDE SPRAYING. THE AUTHORS ATTRIBUTED THIS INCREASE TO EXPOSURE AS A RESULT OF THE SPRAYING OF HERBICIDES CONTAINING TCDD IN SOUTH VIETNAM DURING THE 1960'S (... LIMITATIONS IN REPORTING OF STUDY MAKE IMPOSSIBLE AN ADEQUATE ASSESSMENT OF THE POSSIBLE RELATIONSHIP BETWEEN THE INCIDENCE OF LIVER CANCER & HERBICIDE SPRAYING IN SOUTH VIETNAM)

In 1977 several patients were seen with soft tissue sarcomas and previous exposure to phenoxy acids. This clinical observation resulted in a case referent (case control) study being undertaken which showed that exposure to phenoxy acids or chlorophenols, which are chemically related, gave a roughly six fold increase in the risk for this type of tumor. A further case-referent study of soft tissue sarcomas has now been performed to confirm these earlier findings and also to obtain further information on the effects of different phenoxy acids. This new investigation gave an increase of the same magnitude in the risk for soft tissue sarcomas after exposure to phenoxy acids or chlorophenols, phenois, but this risk related also to exposure to phenoxy acids free from impurities, such as polychlorinated dibenzodioxins and dibenzofurans.

Toxicity Values

Non-Human Toxicity Values:

1. LD50 Dog oral 100-200 ug/kg.
2. LD50 Hamster oral 1,157-5,051 ug/kg.
3. LD50 Rabbit (mixed) oral 115.0 ug/kg.
4. LD50 Rabbit (mixed) dermal 275.0 ug/kg.
5. LD50 Guinea pig (female) oral 2.1 ug/kg.
6. LD50 Rhesus monkey (female) oral <70.0 ug/kg.
7. LD50 Mouse (male) oral 114.0 ug/kg.
8. LD50 Guinea pig (male) oral 0.6 ug/kg.
9. LD50 Rat (male) oral 22.0 ug/kg.
10. LD50 Rat (female) oral 45.0 ug/kg.
11. LD50 Rabbit (mixed) oral 10.0 ug/kg.

IARC Summary and Evaluation:

1. Inadequate evidence of carcinogenicity in humans. Sufficient evidence of carcinogenicity in animals. OVERALL EVALUATION: Group 2B: The agent is possibly carcinogenic to humans.

Populations at Special Risk:

1. Exposure to dioxin (2,3,7,8-tetrachlorodibenzo-p-dioxin) triggered a clinically manifest chronic hepatic porphyria (porphyria cutanea tarda) in patients with hereditary uroporphyrinogen decarboxylase deficiency. Investigations showed that a hereditary disposition was necessary for biochemical & clinical expression of chronic hepatic porphyria after a unique dioxin exposure.

Environmental Fate:

1. TERRESTRIAL FATE: Vertical distribution of TCDD has been monitored in soil at Seveso down to depth of approx 30 cm at several sites & times in 1976 & 1977. As a rule, the amt of TCDD detected more than 8 cm below the surface were approx 1/10 or less than those detected down to 8 cm. Being only slightly sol in water, its migration in soil may have occurred along with soil colloids & particles to which it may have been bound. No definite conclusions may as yet be drawn as to mechanisms responsible for TCDD vertical movement. Moreover, available data indicate that some soil stabilization of TCDD distribution occurred in 1977 as compared to 1976.

Probable Exposures:

1. IN NITRO, WEST VA, USA, IN 1949 & IN ITALY, SYMPTOMS THAT SUGGESTED EXPOSURE TO TCDD (ALTHOUGH AGENT WAS NOT IDENTIFIED) WERE OBSERVED IN WORKERS IN 2,4,5-T & TRICHLOROPHENOL FACTORIES AFTER ACCIDENTAL EXPOSURES. SIMILAR SYMPTOMS WERE OBSERVED IN WORKERS IN 2 TRICHLOROPHENOL FACTORIES IN MITTLE RHINE IN FEDERAL REPUBLIC OF GERMANY IN 1952, IN A 2,4,5-T FACTORY IN USSR & IN 1 IN MIDLAND, MICH, USA IN 1964.
2. OCCUPATIONAL EXPOSURE & ENVIRONMENTAL CONTAMINATION MAY RESULT FROM FORMATION OF DIOXINS DURING SYNTH OF 2,4,5-T, HEXACHLOROPHENE, & /SRP: PURE/ PENTACHLOROPHENOL
3. For 2,4,5-T a Joint Committee of the Food and Agriculture Organization and the World Health Organization has stated (1980) that the "no-effect level" is 3 mg/kg/day and that the ADI for man is 0.003 mg/kg/day when the TCDD content of 2,4,5-T is 0.05 ppm. No similar calculation has been made for hexachlorophene. The USEPA has calculated that, taking into account the cumulative exposure (oral, dermal, and inhalation exposure), a worker would receive 7 mg/kg of 2,4,5-T and 0.0007 ug/kg of TCDD, which is definitely below the "no observable effect level" for TCDD. Whether these values can be accepted as a permissible limit of exposure at the workplace remains at the moment a matter of controversy.
5. At the Diamond Alkali Co., Newark, NJ, workers in the production of the Na-2,4,5-trichlorophenate had potential exposure to 2,3,7,8-TCDD (a contaminant) while operating the autoclave reaction (20 ug/g), collecting samples from the reactor, operating the dilution/filtration product recovery system (10 ug/g), and operating the anisole still and product recovery system (70 ug/g)(1). Potential exposure to reslurry tank and

acidification tank operators was at 20 ug/g. Pre-1967 potential exposure level for production and operator helpers performing formulations and aminizations was 20 ug/g; after 1967 these levels were 1 and 0.5 ug/g, respectively(1).

Occupational Permissible Levels

OSHA Standards:

1. Meets criteria for OSHA medical records rule. *

NIOSH Recommendations:

1. NIOSH IS COMPILING REGISTRY OF CHEM WORKERS IN US WHO HAVE HAD DOCUMENTED EXPOSURE TO CONSTITUENTS OF AGENT ORANGE, SUCH AS 2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN EITHER DURING MFR OF 2,4,5-T & OTHER HERBICIDES OR INDUSTRIAL ACCIDENTS, MORTALITY & REPRODUCTIVE STUDIES ARE PLANNED.

Other Standards and Regulations

Water Standards:

1. Toxic-pollutant-designated pursuant to section 307(a)(1) of the Clean Water Act and is subject to effluent limitations.
2. ... The concentrations of 2,3,7,8-TCDD in drinking water that would result in increased lifetime cancer risks of 1×10^{-4} , 1×10^{-5} , and 1×10^{-6} were estimated to be 2.2×10^{-5} , 2.2×10^{-6} , and 2.2×10^{-7} ug/l respectively.
3. ... Water concentration should be less than 2.0×10^{-6} ug/l in order to keep the individual lifetime risk below 1×10^{-6} ug/kg/day (estimated).

MONITORING AND ANALYSIS METHODS

Sampling Procedures:

1. Sampling procedure for the analysis of polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans. For the determination of 2,3,7,8-TCDD, grab and composite samples must be collected in glass containers. Conventional sampling practices must be followed. The bottle must not be prewashed with sample before collection. Composite samples should be collected in glass containers. Sampling equipment must be free of tygon, rubber tubing, other potential sources of contamination which may absorb the target analytes. All samples must be stored at 4 C, extracted within 30 days, and completely analyzed within 45 days of collection.
2. Grab samples are collected in clean amber glass bottles of 1 l or 1 quart capacity filled with screw caps lined with Teflon or aluminum foil. All samples must be extracted within 7 days and completely analyzed within 40 days of extraction. /Polychlorinated dibenzo-p-dioxins/

Post-It™ brand fax transmittal memo 7671		# of pages >	
To	W. W. W. W.	From	W. W. W. W.
Co.		Co.	
Dept.		Phone #	
Fax #	1-607-694-1093	Fax #	

LEAD (inorganic compounds)

Pb 1977 TLV 0.15 mg/m³

Synonyms: Metallic lead; lead oxide; lead salts, inorganic

Physical Form: Solid

Uses: Storage batteries; paint; ink; ceramics; ammunition.

308 The Chemical Hazards

Exposure: Inhalation; ingestion

Toxicology: Prolonged absorption of lead or its inorganic compounds result in severe gastrointestinal disturbances and anemia; with more serious intoxication there is neuromuscular dysfunction, while the most severe lead exposure may result in encephalopathy.

The onset of symptoms of lead poisoning or plumbism is often abrupt; presenting complaints are often weakness, weight loss, lassitude, insomnia, and hypotension.¹⁻⁴ Associated with these is a disturbance of the gastrointestinal tract which includes constipation, anorexia, and abdominal discomfort or actual colic, which may be excruciating.¹⁻³ Physical signs are usually facial pallor, malnutrition, abdominal tenderness, and pallor of the eye grounds.¹⁻⁴ The anemia often associated with lead poisoning is of the hypochromic, normocytic type with reduction in mean corpuscular hemoglobin; stippling of erythrocytes and reticulocytosis is evident.¹⁻³ On gingival tissues, a line or band of punctate blue or blue-black pigmentation (lead line) may appear, but only in the presence of poor dental hygiene; this is not pathognomic of lead poisoning.³

Occasionally, the alimentary symptoms are relatively slight and are overshadowed by neuromuscular dysfunction accompanied by signs of motor weakness which may progress to paralysis of the extensor muscles of the wrist ("wrist drop") and, less often, of the ankles ("foot drop").^{2, 4} Encephalopathy, the most serious result of lead poisoning, frequently occurs in children owing to the ingestion of inorganic lead compounds, but rarely in adults, except from exposure to organic lead.¹⁻⁴ Nephropathy has been associated with chronic lead poisoning.^{2, 3, 13, 16}

Following absorption, inorganic lead is distributed in the soft tissues, the highest concentrations being in the kidneys and the liver.⁴ In the blood, nearly all circulating inorganic lead is associated with the erythrocytes.⁴ Over a period of time, the lead is redistributed, being deposited especially in bone and also in teeth and hair.^{2, 4} Lead absorption is cumulative; elimination of lead from the body is slow, requiring considerably more time than the period of storage of toxic amounts.¹⁻⁴ Asymptomatic lead workers, when subjected to a sudden increase in expo-

spond with an episode of typical lead poisoning.¹ Removal of the worker from exposure to abnormal quantities of lead often leads to a seemingly sudden and apparently complete recovery; this has occurred even when the individual had a considerable quantity of residual lead in the body.¹

The upper limits of lead levels traditionally classified as normal are 40 µg/100 ml blood and 80 µg/liter of urine; the lower limit of values classified as excessive are 80 µg/100 ml blood and 150 µg/liter of urine. At or above these levels action must be taken to reduce the worker's absorption of lead.^{4, 6} One observer has noted decreased eye-hand coordination in workers with blood lead levels between 70 and 79 µg/100 ml blood.¹⁷ Some investigators believe that serious subclinical effects occur at blood lead levels as low as 60 µg/100 ml blood.⁹

Epidemiologic studies have not shown a relation between lead exposure and the incidence of cancer.⁷⁻⁹ There are several reports that lead administered to animals in high doses is carcinogenic.^{4, 18, 19} Lead penetrates the placental barrier and has caused congenital abnormalities in animals.^{3, 20} Excessive exposure to lead during pregnancy has resulted in neurologic disorders in infants, although the possibility of postnatal exposure of the infants to lead cannot be excluded.^{21, 22} In battery workmen with a mean occupational exposure to lead of 3.5 (one to 23) years and with blood lead concentrations of 53 to 75 µg/100 ml of blood, there was an increased frequency of abnormalities of sperm, including hypospermia, as compared with a control group.²³

The TLV is set at a level to prevent systemic effects.²⁶

Diagnosis: Signs and symptoms include weakness, lassitude, insomnia; facial pallor and pallor of the eye grounds; anorexia, weight loss, malnutrition; constipation, abdominal discomfort and tenderness; colic; anemia; lead line on gingival tissues; signs of motor weakness, including paralysis of the extensor muscles of wrist and, less often, of the ankles; encephalopathy; nephropathy.

Differential Diagnosis: The diagnosis of acute lead poisoning is based on a full consideration of metabolic, functional, and clinical factors.³ Symptomatic lead poisoning may

Lead (Inorganic Compounds) 309

$\mu\text{g}/100$ ml of whole blood in the presence of the following: anemia due to other causes; severe anemia due to lead poisoning; renal insufficiency; or sickle cell disease. If inorganic lead contributes to the symptom complex in such patients, either the heme precursors will be greatly increased, the response to the Ca EDTA mobilization test will be abnormal, or both (see Special Tests).

In view of the nonspecificity of mild symptoms of acute lead poisoning and the ease which they may be confused with acute alcoholism, acute intermittent porphyria, and various surgical and nonsurgical abdominal conditions, a thorough laboratory evaluation with respect to lead is essential; even then, differential diagnosis may be difficult.

Special Tests: A neurologic examination with electromyography and nerve conduction velocity is useful. The concentration of lead in the blood is the best single indication of exposure to inorganic lead; blood lead is less variable than urinary lead.² Blood lead determination is an exacting laboratory procedure requiring constant attention to quality control.

Other indicators of lead exposure relate to the inhibition by lead of the synthesis of heme. The inhibition of delta-aminolevulinic acid dehydrase (ALA-D), an enzyme involved in porphyrin synthesis, leads to an increase in levels of delta-aminolevulinic acid (ALA) in blood and urine.³ The blood and urine levels of coproporphyrin III and free erythrocyte protoporphyrins (FEP) are also usually elevated.³ FEP combines with zinc in the blood to form zinc protoporphyrin (ZP), which is the moiety assayed.^{23, 27} The FEP test is performed on blood and has recently achieved prominence with its acceptance by the Public Health Service as an alternative to blood lead testing in the screening of children for lead poisoning.^{2, 10, 24, 25} ALA-D, ALA, coproporphyrin III assays, and blood examinations for hemoglobin, reticulocytes, and stippled red cells are useful in the assessment of worker health, but no one of these measurements alone is an accepted specific index of lead absorption.¹¹

The Ca EDTA mobilization test for lead is presently used for estimating both current and previous absorption of increased amounts of lead.^{2, 11, 12} In this test, a single dose of 1 g. Ca

EDTA is infused intravenously over a period of one hour. Urine is then collected quantitatively for 24 hours (four days in subjects with renal insufficiency); the upper limits in healthy adult subjects is 500 to 600 μg of lead excreted in the urine.

Treatment: In acute lead poisoning, administer Ca EDTA (edathamil calcium disodium, Versenate) by continuous slow IV 2 g./day (mild cases) or 3 to 4 g./day (cautiously in severe cases). The concentration of Ca EDTA in 5 per cent D/W or NS should not exceed 0.5 per cent; infuse the total daily dose in 12 to 24 hours (minimum safe infusion time is eight hours).¹² Maximum course is five days.

Precautions: Ca EDTA has caused proteinuria, microscopic hematuria, large epithelial cells in the urinary sediment, hypercalcemia, and fever, and therefore it should not be used during periods of anuria. Safe administration of Ca EDTA requires the following determinations on the first, third, and fifth day of each course of therapy: serum electrolytes; urea nitrogen, calcium, phosphorus, and alkaline phosphatase measurements in blood; and routine urinalysis.¹² The patient should also be monitored for irregularities of cardiac rhythm.

Note: The oral administration of Ca EDTA to workers exposed to lead as prophylactic therapy has been considered and practiced by some. This practice is condemned on the following counts: (1) only 2 to 5 per cent of an administered dose of Ca EDTA is absorbed from the gastrointestinal tract; (2) Ca EDTA given orally increases the absorption of lead from the bowel and may precipitate or aggravate symptoms of lead poisoning.^{14, 28}

Medical Control: Preplacement and annual physical examination with emphasis on the nervous system, gastrointestinal tract, blood, and kidneys; complete blood cell count; urinalysis; blood lead.

References

Principal

1. Kehoe, R. A.: Occupational lead poisoning. I. Clinical types. *J. Occup. Med.*, 14:298, 1972.

Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855



GENIUM PUBLISHING CORP.

No. 26

MERCURY
(Revision C)
Issued: September 1981
Revised: August 1988

SECTION 1. MATERIAL IDENTIFICATION

26

Material Name: MERCURY

Description (Origin/Uses): Used in barometers, thermometers, hydrometers, and pyrometers; in mercury arc lamps producing ultraviolet rays; in switches and fluorescent lamps; as a catalyst in oxidations of organic compounds; in alloys; in explosives; and for extracting gold and silver from ore.

Other Designations: Colloidal Mercury; Metallic Mercury; Quicksilver; Hg; Hydrargyrum;

CAS No. 7439-97-6

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek*

Buyers' Guide (Genium ref. 73) for a list of suppliers.

Comments: Inorganic and organic mercury compounds are highly toxic, as is pure mercury.



Genium

HMIS

H 3 R 1

F 0 I 4

R 0 S 1

PPG* K 0

*See sect. 8

SECTION 2. INGREDIENTS AND HAZARDS

%

EXPOSURE LIMITS

Mercury, CAS No. 7439-97-6

Ca 100

OSHA PEL

Ceiling: 1 mg per 10 m³

ACGIH TLV (Skin*), 1987-88

TLV-TWA: 0.05 mg/m³ as Hg (Mercury Vapor)

Toxicity Data**

Rabbit, Inhalation, LC₅₀: 29 mg/m³ (30 Hrs)

*Mercury can be absorbed through intact skin, which contributes to overall exposure.

**See NIOSH, RTECS (OV4550000), for additional data with references to reproductive, mutagenic, and tumorigenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 673°F (357°C)

Specific Gravity (H₂O = 1): 13.546 at 68°F (20°C)

Vapor Pressure: 0.0018 Torr at 77°F (25°C)

Water Solubility (%): Insoluble

Molecular Weight: 201 Grams/Mole

Melting Point: -37.93°F (-38.85°C)

Appearance and Odor: A silver, heavy liquid; odorless. Danger: Mercury vapor has no warning properties.

SECTION 4. FIRE AND EXPLOSION DATA

LOWER

UPPER

Flash Point and Method

Autoignition Temperature

Flammability Limits in Air

*

*

% by Volume

*

*

Extinguishing Media: *Mercury does not burn. Use extinguishing agents that will put out the surrounding fire.

Unusual Fire or Explosion Hazards: When exposed to the high temperatures that occur during a fire, mercury can vaporize to form extremely toxic fumes.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Mercury is stable in closed containers at room temperature under normal storage and handling conditions. It cannot undergo hazardous polymerization.

Chemical Incompatibilities: Hazardous reactions involving mercury and acetylene, ammonia, boron phosphodiiodide, chlorine, chlorine dioxide, methyl azide, sodium carbide, nitric acid, oleum, and sulfuric acid are reported (Genium ref. 84).

Conditions to Avoid: Do not expose mercury to incompatible chemicals.

Hazardous Products of Decomposition: Extremely toxic mercury metal fumes are likely to be produced during fires.

SECTION 6. HEALTH HAZARD INFORMATION

Mercury is not listed as a carcinogen by the NTP, IARC, or OSHA.

Summary of Risks: Mercury is very toxic due to its liquid and fat solubility, lack of charge, and membrane permeability. It is a slowly cumulative poison that concentrates in the brain, kidneys, and liver. It is very hazardous when spilled or heated. Mercury and its vapor are rapidly absorbed by the membranes lining the respiratory tract, the gastrointestinal (GI) tract, and the skin. Mercury is a teratogen (causes physical defects in embryos). **Medical Conditions Aggravated by Long-Term Exposure:** Preexisting problems of the target organs can be worsened. Provide preplacement and periodic medical exams emphasizing the target organs. **Target Organs:** Skin, eyes, respiratory system, central nervous system (CNS), kidneys. **Primary Entry:** Skin absorption/contact, inhalation. **Acute Effects:** Erosion of the respiratory/GI tracts, nausea, vomiting, bloody diarrhea, shock, headache, metallic taste. Inhalation of high concentrations for short periods can cause pneumonitis, chest pain, dyspnea, coughing, stomatitis, gingivitis, and salivation. **Chronic Effects:** Tremors, emotional problems, loss of concentration, depression, drowsiness, fatigue, insomnia, loss of memory, kidney problems, eye lesions, vision disturbances, sore mouth and throat, problems with the sense of taste or smell, nosebleeds, nasal inflammation, loss of weight or appetite, poor hand-eye coordination, awkwardness, and unsteadiness, as well as dermatitis. **FIRST AID:** **Eyes:** Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. **Skin:** Immediately wash the affected area with soap and water because of the increased exposure from skin absorption. **Inhalation:** Remove exposed person to fresh air; restore and/or support his or her breathing as needed. Have medical personnel administer oxygen to treat the chemical pneumonitis that may develop. **Ingestion:** Never give anything by mouth to someone who is unconscious or convulsing. Note to physician: If indicated by degree of ingestion, saline cathartics and charcoal should be used. Chelation therapy with D-penicillamine may also be indicated.

GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid. Treatment of chronic mercury poisoning requires expert medical care. At the first signs, immediately remove the exposed person from further exposure and have him or her examined and treated by a physician trained in occupational mercury poisoning.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, restrict access to the spill area to necessary personnel, and provide adequate ventilation. Clean up spills promptly. Specialized equipment and/or techniques may be required to safely deal with large mercury spills; if large quantities of mercury are used in the workplace, detailed, prior spill-management planning is recommended. Collect spilled mercury by using a suction pump and an aspirator bottle with a long capillary tube. For finely divided mercury in inaccessible cracks, corners, etc., treatment with calcium polysulfide and excess sulfur is recommended to convert the mercury globules into mercury sulfide. Vacuum cleaners may be used if they are equipped with specially designed mercury-absorbent exhaust filters. Collect the mercury into tightly sealed containers for later disposal or reclamation. Cleanup personnel must use the recommended personal protective equipment (see sect. 8).

Waste Disposal: Consider reclamation, recycling, or destruction rather than disposal in a landfill. Do not pour mercury down a drain. Mercury is very harmful to the environment. Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations

— Air Contaminant (29 CFR 19010.1000 Subpart Z)

EPA Designations (40 CFR 302.4)

RCRA Hazardous Waste No. U151

CERCLA Hazardous Substance, Reportable Quantity: 1 lb (0.454 kg)*

*Per the Clean Water Act, § 407 (a); Clean Air Act, § 112; and Resource Conservation and Recovery Act, § 3001.

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing of mercury may occur, wear a full face shield or splash guard. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Use a NIOSH-approved respirator per the *NIOSH Pocket Guide to Chemical Hazards* for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). **Other:** Wear impervious gloves, boots, aprons, gauntlets, etc., to prevent any contact with mercury and the skin.

Ventilation: Install and operate general and local ventilation systems powerful enough to continuously maintain airborne levels of mercury below the OSHA PEL standard cited in section 2.

Safety Stations: Make emergency eyewash stations, washing facilities, and safety/quick-drench showers available in work areas.

Contaminated Equipment: Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Do not wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean mercury from shoes and equipment. Separate work and street clothes; store work clothes in special lockers and always shower before changing to street clothes.

Comments: Practice good personal hygiene; always wash thoroughly after using this material. Keep it off of your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do not eat, drink, or smoke in any work area.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store mercury in a cool, dry, well-ventilated area in tightly closed unbreakable polyethylene containers. Protect these containers from physical damage.

Special Handling/Storage: Construct storage areas to have smooth, hard, nonporous floors with no cracks or spaces so that spilled mercury globules do not form in inaccessible areas.

Comments: Mercury evaporates slowly, but if it is spilled it can form many tiny globules that evaporate much faster than a single pool of it will. In an unventilated area, significant concentration of mercury vapor can develop from this enhanced evaporation effect. This poisonous vapor is particularly hazardous if breathed over a long period of time, so spills or releases of mercury require very meticulous cleaning procedures.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Mercury, Metal

DOT Hazard Class: ORM-B

DOT Label: None

DOT ID No. NA2809

IMO Class: 8

IMO Label: Corrosive

References: 1, 2, 8, 26, 38, 84-94, 100.

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Prepared by PJ Igoe, BS

Industrial Hygiene Review: DJ Wilson, CIH

Medical Review: MJ Hardies, MD

NDA000

HR: 3

NICKEL(II) CHLORIDE HEXAHYDRATE (1:2:6)

CAS: 7791-20-0

NIOSH: QR 6480000

mf: $\text{Cl}_2\text{Ni}\cdot 6\text{H}_2\text{O}$ mw: 237.73

PROP: A: Yellow, deliquescent scales; b: monoclinic, green crystals. A: NiCl_2 , b: $\text{NiCl}_2\cdot 6\text{H}_2\text{O}$; mw (a): 129.60, mw (b): 237.70, mp (a): sublimes, bp (a): 987° , d (a): 3.55, vap press: 1 mm @ 671° .

TOXICITY DATA:

cyt-mus:mmr 100 $\mu\text{mol/L}$

sce-ham:fbr 32 mg/L

ipr-mus LD50:48 mg/kg

ivn-dog LD50:40 mg/kg

CODEN:

MUREAV 68,337,79

MUREAV 104,141,82

AEPPAE 244,17,62

EQSSDX 1,1,75

Nickel and its compounds are on the Community Right To Know List.

OSHA PEL: TWA 1 mg(Ni)/ m^3 ACGIH TLV: TWA 0.1 mg(Ni)/ m^3 NIOSH REL: (Inorganic Nickel) TWA 0.015 mg(Ni)/ m^3

THR: Poison by intraperitoneal and intravenous routes. Mutagenic data. Violent reaction with K. When heated to decomposition it emits very toxic fumes of Cl^- . See also NICKEL COMPOUNDS and CHLORIDES.

NDA500

HR: 3

NICKEL, COMPOUND with pi-CYCLOPENTADIENYL (1:2)

CAS: 1271-28-9

NIOSH: QR 6500000

mf: $\text{C}_{10}\text{H}_{10}\cdot\text{Ni}$ mw: 188.91

SYNS:

pi-CYCLOPENTADIENYL COM-
POUND WITH NICKEL
DI-pi-CYCLOPENTADIENYL-
NICKEL

NICKEL BISCYCLOPENTADIENE
NICKELOCENE

TOXICITY DATA:

ims-rat TDLo:600 mg/kg/52W-I:

NEO

ims-ham TDLo:200 mg/kg:

NEO

ims-rat TD :600 mg/kg/47W-I:

NEO

ims-rat TD :650 mg/kg/1Y-I:

NEO

ims-rat TD :1260 mg/kg/56W-I:

NEO

ims-rat TD :50 mg/kg:ETA

ims-rat TD :50 mg/kg:NEO

ori-rat LD50:490 mg/kg

ipr-rat LD50:50 mg/kg

ims-rat LD50:82 mg/kg

ori-mus LD50:600 mg/kg

ipr-mus LD50:86 mg/kg

CODEN:

NCIUS* PH 43-64-

886,DEC,65

PWPSA8 14,68,71

NCIUS* PH 43-64-

886,JUL,68

PWPSA8 14,68,71

NCIUS* PH 43-64-

886,DEC,68

NCIUS* PH-43-64-

886,SEPT,65

NCIUS* PH 43-64-

886,AUG,69

PWPSA8 11,39,68

NCIUS* PH 43-64-

886,JAN,65

NCIUS* PH 43-64-

886,AUG,64

PWPSA8 11,39,68

PWPSA8 11,39,68

IARC Cancer Review: Animal Inadequate Evidence IMEMDT 2,126,73; Animal Sufficient Evidence IMEMDT 11,75,76. Nickel and its compounds are on the Community Right To Know List. Reported in EPA TSCA Inventory.

NIOSH REL: TWA 15 $\mu\text{g}(\text{Ni})/\text{m}^3$

THR: Poison by intraperitoneal and intramuscular routes. Moderately toxic by ingestion. An experimental carcinogen, neoplastigen and tumorigen. When heated to decomposition it emits acrid smoke and irritating fumes. See also NICKEL COMPOUNDS.

NDB000

HR: 3

NICKEL COMPOUNDS

Nickel and its compounds are on the Community Right To Know List.

THR: Nickel and many of its compounds are poisons and carcinogens. Some are human carcinogens by inhalation. All airborne nickel contaminating dusts are regarded as carcinogenic by inhalation. Nickel carbonyl is probably the most hazardous compound of nickel in the workplace. It is carcinogenic and highly irritating to the lungs and can produce asphyxia by decomposing to form carbon monoxide. Nickel chloride (NiCl_2), sulfate ($\text{NiSO}_4\cdot 6\text{H}_2\text{O}$), nitrate [$\text{Ni}(\text{NO}_3)_2\cdot 6\text{H}_2\text{O}$], carbonate (NiCO_3), hydroxide [$\text{Ni}(\text{OH})_2$] and acetate [$\text{Ni}(\text{COOCH}_3)_2$] are the salts of great commercial importance.

Ingestion of large doses of nickel compounds (1-3 mg/kg) has been shown to cause intestinal disorders, convulsions, and asphyxia. Hypersensitivity to nickel is common and can cause allergic contact dermatitis, pulmonary asthma, conjunctivitis, and inflammatory reactions around nickel-containing medical implants and prostheses. The most common effect resulting from exposure to nickel compounds is the development of "nickel itch". It occurs primarily in persons doing nickel-plating and is most frequent under conditions of high temperature and humidity, when the skin is moist, and mainly affects the hands and arms. There is marked variation in individual susceptibility to the dermatitis.

Nickel refinery workers experience increased mortality rates from cancer of the lungs and nasal cavities attributed to inhalation of airborne nickel compounds. Cancer develops in rodents after administration of Ni_3S_2 , NiO , and $\text{Ni}(\text{CO})_4$. Nickel chloride, sulfate, carbonate, and carbonyl are experimental teratogens.

Pulmonary damage develops in rodents chronically exposed to aerosols of nickel dust, NiCl_2 , or NiO . Divalent nickel salts cause hyperglycemia, immune system effects, kidney damage, liver damage, and heart effects in experimental animals by parenteral administration. These compounds are common air contaminants. See also NICKEL and specific compounds.

THERAP CAT: Vasodilator.

c1ccc(cc1)C(=O)OCC(C(=O)OCC2=CC=CC=C2N)C(=O)OCC3=CC=CC=C3N

Caution: May cause dermatitis in sensitive individuals. Ingestion of soluble salts causes nausea, vomiting, diarrhea: E. Browning, *Toxicity of Industrial Metals* (Appleton-Century-Crofts, New York, 2nd ed., 1969) pp 249-260. This substance and certain nickel compounds have been

6343. Nickel Chloride. Nickel dichloride. Cl_2Ni ; mol wt 129.61. Cl 54.70%, Ni 45.30%. NiCl_2 .

C#C[Ni]1OCCO1

Monohydrate, apple-green
to form NiO and H_2O . Inso
ammonia.

6349. Nickel Iodide. Ni 312.51, I 81.21%, Ni 18.79%. Iron-black color. Sublimes in air. Insoluble in water, ether or alcohol. *Keep well closed.*

Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855



GENIUM PUBLISHING CORP.

No. 136

SELENIUM

Issued: April 1988

SECTION 1. MATERIAL IDENTIFICATION

25

Material Name: SELENIUM

Description (Origin/Uses): Used to manufacture other selenium compounds; also used in photography and xerography and as a catalyst and pigment.

Other Designations: Elemental Selenium; Selenium Base; Selenium Dust; Selenium Metal; Selenium Metal Powder; Se; NIOSH RTECS No. VS7700000; CAS No. 7782-49-2

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

Comments: See Genium Industrial MSDS 152 (Selenium Dioxide).

HMIS Not Found
H 3
F 0 R 1
R 1 I 4
PPG* S 2
*See sect. 8 K 0



SECTION 2. INGREDIENTS AND HAZARDS

%

EXPOSURE LIMITS

Selenium, CAS No. 7782-49-2

ca 100

IDLH* Level: 100 mg/m³

OSHA PEL**
8-Hr TWA: 0.2 mg/m³

ACGIH TLV,** 1987-88
TLV-TWA: 0.2 mg/m³

*Immediately dangerous to life and health

**This exposure limit is defined for selenium compounds as Se.

***See NIOSH, RTECS, for additional data with references to reproductive, mutagenic, and tumorigenic effects.

Toxicity Data***

Rat, Oral, LD₅₀: 6700 mg/kg

Rat, Inhalation, LD₅₀: 33 mg/kg (8 Hrs)

SECTION 3. PHYSICAL DATA

Boiling Point: ca 1263°F (684°C)

Water Solubility: Insoluble

Melting Point: ca 644°F (340°C)

Specific Gravity (H₂O = 1): Both amorphous and crystalline forms have specific gravities between 4 and 5.
Molecular Weight: 79 Grams/Mole

Appearance and Odor: A dark red to bluish black amorphous solid or dark red, grey, or black crystals appearing in two distinct forms, or allotropes, because of differences in crystalline structures; odorless.

SECTION 4. FIRE AND EXPLOSION DATA

LOWER

UPPER

Flash Point and Method

Autoignition Temperature

Flammability Limits in Air

*

*

% by Volume

*

*

Extinguishing Media: *Selenium does not burn. Use agents such as dry chemical, "alcohol" foam, or carbon dioxide that will extinguish the surrounding fire.

Unusual Fire or Explosion Hazards: None.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Selenium is stable in closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization.

Chemical Incompatibilities: This material reacts dangerously with carbides, fluorine, oxygen, potassium, and many more materials (see Genium ref. 84).

Conditions to Avoid: Avoid direct contact with incompatible chemicals to prevent dangerous and violent reactions. Avoid the unintended contact of water with selenium in storage areas or reactor vessels.

Hazardous Products of Decomposition: When heated to decomposition, selenium readily emits toxic oxides of selenium (SeO₂). Selenium itself is a highly toxic and dangerous material.

SECTION 6. HEALTH HAZARD INFORMATION

Selenium is not listed as a carcinogen by the NTP, IARC, or OSHA.

Summary of Risks: Direct exposure to selenium or inhalation of its dust causes severe irritation of the skin, eyes, and the upper respiratory tract (URT). **Caution:** Some symptoms of exposure to selenium (e.g., chemical pneumonia) may be delayed for several hours. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** URT, skin, eyes. **Primary Entry:** Inhalation, skin contact. **Acute Effects:** Skin and eye burns, contact dermatitis, intense irritation of the URT, and headache. Cases with flu-like symptoms resembling metal-fume fever within 24 hours of exposure have been reported.

Chronic Effects: Odor of garlic on breath; fatigue; irritability; URT irritation; pallor; gastrointestinal distress; metallic taste; and an allergic eye reaction with red, sometimes puffy, eyelids.

FIRST AID: **Eyes.** Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water.

Skin. Immediately wash the affected area with plenty of running water. Any worker who develops a rash or contact dermatitis must get medical attention and prevent any further contact with selenium metal or its compounds (e.g., selenium dioxide; see Genium Industrial MSDS 152). **Inhalation.** Remove exposed person to fresh air; restore and/or support his or her breathing as needed. Prompt administration of oxygen gas (O₂) by trained medical personnel may aid recovery. **Ingestion.** Give exposed person several glasses of water to dilute material. Do not induce vomiting. Never give anything by mouth to someone who is unconscious or convulsing.

Treat each exposure to selenium as an emergency! GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid. If chelation therapy to remove the metallic selenium is indicated, calcium disodium edetate (CaNa₂-EDTA) is the chelating agent of choice; do *not* use dimercaprol. Burns may require treatment with 10% sodium thiosulfate cream.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate all nonessential personnel, provide adequate ventilation, and do not add any water to the spill or leak area. Cleanup personnel need protection against contact with and inhalation of dust (see sect. 8). Scoop up spilled selenium into suitable containers for disposal. Carefully sweep or vacuum up small spills or residues without creating dust.

Waste Disposal: Contact your supplier or a licensed contractor for detailed recommendations for disposal. Follow Federal, state, and local regulations.

OSHA Designations

Air Contaminant (29 CFR 1910.1000 Subpart Z)

EPA Designations (40 CFR 302.4)

RCRA Hazardous Waste: Listed without a Number

CERCLA Hazardous Substance, Reportable Quantity: 1 lb (0.454 kg)

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Follow the eye- and face-protection guidelines in 29 CFR 1910.133. **Respirator:** Use a NIOSH-approved respirator per the *NIOSH Pocket Guide to Chemical Hazards* for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow the respirator guidelines in 29 CFR 1910.134. For emergency or nonroutine use (e.g., cleaning reactor vessels or storage tanks) wear an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres.

Other: Wear impervious gloves; boots; aprons; and clean, impervious, body-covering clothing to prevent any possibility of skin contact.

Ventilation: Install and operate general and local maximum explosion-proof ventilation systems powerful enough to maintain airborne levels of selenium below the OSHA PEL standard cited in section 2. **Safety Stations:** Make eyewash stations, washing facilities, and safety showers available in areas of use and handling. Make the 10% sodium thiosulfate solution or cream and the CaNa₂-EDTA chelating agent formula (sect. 6) readily available to a trained safety specialist. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Particles can adhere to contact lenses and cause corneal damage. Do *not* wear contact lenses in any work area.

Comments: Practice good personal hygiene; always wash thoroughly after using this material. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store selenium in a cool, dry, well-ventilated area in tightly closed containers away from oxidizing agents, organic materials, water, metals, and incompatible chemicals (see sect. 5). **Special Handling/Storage:** Prevent moisture or water contamination in any storage facility. Consider installing an automatic monitoring system to detect selenium contamination; storage under an inert gas (e.g., a nitrogen blanket) may be warranted depending on the work environment. **Engineering Controls:** Use selenium in closed engineering systems because of its significant health and physical hazards (see sects. 4, 5, and 6). All engineering systems (production, transportation, etc.) should be of maximum explosion-proof design (i.e., they must be nonsparking, electrically grounded and bonded, etc.). **Comments:** Perform all work with selenium with a sustained, conscientious effort to prevent accidental contact with water. Do not create a dusty working environment. Develop a sustained, conscientious program of working guidelines prior to any accidental exposure.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Selenium Metal Powder

DOT Label: Poison

IMO Label: St. Andrew's Cross (X)*

DOT Class: Poison B

DOT ID No. UN2658

IMO Class: 6.1

*Harmful-Stow away from Foodstuffs (IMO Label, Materials of Class 6.1 Packaging Group III)

References: 1, 2, 12, 73, 84-94, 100, 103.

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Prepared by PJ Igoe, BS

Industrial Hygiene Review: DJ Wilson, CIH

Medical Review: MJ Hardies, MD

Material Safety Data Sheet

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855



No. 181

SILVER

Issued: April 1986

SECTION 1. MATERIAL IDENTIFICATION

20

MATERIAL NAME: SILVER

DESCRIPTION: Elemental metal.

OTHER DESIGNATIONS: Ag, Argentum, CAS #7440-22-4.

MANUFACTURER/SUPPLIER: Available from many suppliers.

COMMENTS: Photography products account for 30% of industrial consumption. Additional uses include electrical conductors, coins, silverware, and jewelry.

HMIS

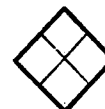
H:1

F:0

R:0

PPE*

*Sec sect. 8



Not Found

SECTION 2. INGREDIENTS AND HAZARDS

%

HAZARD DATA

Silver, Ag

99+

TWA 0.1 mg/m³*

TWA 0.01 mg/m³**

* Current (1985-86) ACGIH TLV for silver dust and fume.

** Current (1985-86) ACGIH TLV for soluble silver compounds and OSHA exposure limit.

Rat, Implant, TD: 2570 mg/kg

SECTION 3. PHYSICAL DATA

Boiling Point ... 3833.6°F (2112°C)

Vapor Pressure ... Not Found

Water Solubility ... Insoluble

Vapor Density (Air = 1) ... Not Found

Evaporation Rate ... Not Found

Specific Gravity (H₂O = 1) ... 10.5

Melting Point ... 1763.4°F (961.9°C)

Percent Volatile by Volume ... Not Found

Molecular Weight ... 107.87

Appearance and odor: Ductile and malleable lustrous white metal.

SECTION 4. FIRE AND EXPLOSION DATA

LOWER

UPPER

Flash Point and Method

Autoignition Temp.

Flammability Limits In Air

Not Found

Not Found

Not Found

Not

Applicable

Not

Applicable

NFPA Classification: Noncombustible.

EXTINGUISHING MEDIA: Use proper extinguisher for surrounding fire.

UNUSUAL FIRE/EXPLOSION HAZARDS: None.

SPECIAL FIRE-FIGHTING PROCEDURES: None.

SECTION 5. REACTIVITY DATA

Silver is stable. Hazardous polymerization cannot occur.

CHEMICAL INCOMPATIBILITIES: Acetylene and silver form an insoluble, explosive acetylide. If silver is treated with nitric acid in the presence of ethyl alcohol, silver fulminate may be formed, which can be detonated.

Ethylenimine forms explosive compounds with silver. Finely divided silver and hydrogen peroxide solutions may explode.

This material is incompatible with oxalic and tartaric acid. Ammonia plus silver may form explosive compounds.

Bromoazide explodes on contact with silver foil.

SECTION 6. HEALTH HAZARD INFORMATION | TLV

Silver is not considered a carcinogen by the NTP, IARC, or OSHA.

SUMMARY OF RISKS: Silver has no known physiological function in man and will accumulate in most tissues. Chronic accumulation (threshold in excess of 1 gram) in the body can result in argyria, a permanent condition associated with widespread bluish pigmentation of the skin and conjunctiva. **TARGET ORGANS:** Generally, where contact occurs. **PRIMARY ENTRY:** Inhalation, long-term handling (causes particles to become embedded in skin), or absorption through sweat glands. **ACUTE EFFECTS** are associated with soluble silver compounds that may be caustic, causing local irritations or destruction of tissue, depending upon strength of solution. **CHRONIC EFFECTS:** Argyria may be a local or general effect, depending upon previous exposure. **FIRST AID:** **EYE CONTACT:** Flush with water for 15 minutes. Get medical attention.* **SKIN CONTACT:** Wash skin with soap and water. Argyria from long-term exposure is permanent and cannot be washed away. **INHALATION:** Remove victim to fresh air. **INGESTION:** Dilute with water. Get medical attention.*

* **GET MEDICAL ASSISTANCE** = In plant, paramedic, community. Get medical help for further treatment, observation, and support after first aid, if indicated.

COMMENTS: The original 0.01 mg/m³ TLV was established to prevent a lifetime body accumulation exceeding 1 gram, where argyria would become evident. Evaluation of 25 years of data has shown 0.01 mg/m³ to be too conservative; therefore, the ACGIH raised the TLV to 0.1 mg/m³.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

SPILL/LEAK: Notify safety personnel; prevent entry into sewers or surface waters. Wear respirator where a dusting hazard is anticipated.

WASTE DISPOSAL: Reclaim or sell waste to a commercial reclaimer.

SECTION 8. SPECIAL PROTECTION INFORMATION

GOGGLES are not required unless metal is in the molten state.

GLOVES: Repeated handling may discolor the skin because of skin rubbing against the metal. Cotton gloves will prevent this cosmetic effect.

RESPIRATOR is required where metal dust or fumes are generated with inadequate exhaust ventilation. Air samples should be collected to quantify the exposure levels.

VENTILATION is required where air exposures exceed the TLV-TWA'S.

OTHER: Reclamation of silver from photographic or X-ray film may involve cyanide compounds. Proper precautions must be taken when working with cyanide compounds. See Genium MSDS #13, Potassium Cyanide, for further information.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

STORAGE SEGREGATION: Silver is usually stored in locked cabinets or safes to prevent theft.

ENGINEERING CONTROLS: Exhaust ventilation where TLV-TWA is exceeded.

EPA Hazardous Substance Designation: 40 CFR 260

Data Source(s) Code: 2, 4, 6, 14, 59, 82, 84, NFC 1983. DW

Judgements as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Approvals *JO. A. ARACCO, 11/86*

Indust. Hygiene/Safety *JW 10-86*

Medical Review *[Signature] 10-86*

Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855



GENIUM PUBLISHING CORP.

No. 80

THALLIUM METAL
(Revision A)

Issued: December 1980
Revised: April 1988

25

SECTION 1. MATERIAL IDENTIFICATION

Material Name: THALLIUM METAL

Description (Origin/Uses): Used in semiconductor research; also alloyed with mercury for the manufacture of switches and closures that operate at subzero temperatures.

Other Designations: TI; NIOSH RTECS No. XG3425000; CAS No. 7440-28-0

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

Comments: The hazards of working with thallium metal are associated with cutting, grinding, welding, etc., that produce dust, fumes, powders, and gases.

HMIS

Not Found

H 1

F 1

R 1

PPG*

R 1

I 3

S 1

*See sect. 8

K -

SECTION 2. INGREDIENTS AND HAZARDS

%

EXPOSURE LIMITS

Thallium Metal, CAS No. 7440-28-0

Ca 100

IDLH* Level: 20 mg/m³ (Soluble Compounds)

OSHA PEL (Skin**)

8-Hr TWA:*** 0.1 mg/m³

ACGIH TLV, 1987-88

TLV-TWA:*** 0.1 mg/m³

Toxicity Data****

Man, Oral, TD₀₁: 5.714 mg/kg

*Immediately dangerous to life and health (soluble).

**This material or its salts can be absorbed through intact skin, which contributes to overall exposure.

***Exposure limit defined for soluble thallium compounds as TL.

****See NIOSH, RTECS, for additional data.

SECTION 3. PHYSICAL DATA

Boiling Point: 2655°F (1457°C)

Melting Point: 579°F (304°C)

Specific Gravity (H₂O = 1): 11.85

Water Solubility (%): Insoluble

Molecular Weight: 204 Grams/Mole

Appearance and Odor: A bluish white, very soft, easily fusible heavy metal; odorless.

SECTION 4. FIRE AND EXPLOSION DATA

LOWER

UPPER

Flash Point and Method

Autoignition Temperature

Flammability Limits in Air

% by Volume

Extinguishing Media: *Use dry chemical, "alcohol" foam, carbon dioxide, or water spray to put out thallium fires. Contact your supplier for further recommendations.

Unusual Fire or Explosion Hazards: Thallium metal dust particles suspended in the air can explode. If a thallium dust cloud forms, immediately eliminate all possible sources of ignition such as sparks, open flame, etc., and spray the area with a water mist or fog. Working with this material can produce heat and sparks, which can ignite flammable materials and vapors in the workplace.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Thallium metal is stable in closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization. In air, a poisonous coating of thallium oxide (Tl₂O) can develop on the exposed surface of thallium metal.

Chemical Incompatibilities: This material reacts violently with fluorine.

Conditions to Avoid: Prevent contact with fluorine. Avoid exposure to sources of ignition such as open flame, sparks, and lighted tobacco products.

Hazardous Products of Decomposition: During fires thallium can form thallium oxide.

SECTION 6. HEALTH HAZARD INFORMATION

Thallium metal is not listed as a carcinogen by the NTP, IARC, or OSHA.

Summary of Risks: Thallium is a cumulative poison. It or its salts can be absorbed through intact skin; if they are ingested they are rapidly absorbed by the gastrointestinal (GI) tract. Thallium acts as a mitotic (affecting cell division) agent and a general cellular poison. Acute poisoning chiefly affects the central nervous system (CNS) and the GI tract. The ingestion of soluble thallium salts causes more serious effects than the ingestion of the pure metal. **Medical Conditions Aggravated by Long-Term Exposure:** Disorders of the CNS, GI tract, kidneys, liver, and eyes may be worsened by exposure to thallium. Administer preplacement and periodic medical exams emphasizing these organs' functions. **Target Organs:** Eyes, CNS, lungs, liver, kidneys, GI tract. **Primary Entry:** Skin absorption or contact, inhalation. **Acute Effects:** Nausea, vomiting, diarrhea, tingling or pain in the extremities, weakness, coma, convulsions, and death. **Chronic Effects:** Weakness, pain in the extremities (polyneuritis); loss of hair (alopecia, the most visible sign); and disorders of the cardiac, renal, and endocrine systems. **FIRST AID:** **Eyes.** Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. **Skin.** Immediately wash the affected area with soap and water because of the increased hazard from absorption. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. **Ingestion.** *Treat as an emergency.* Never give anything by mouth to someone who is unconscious or convulsing. If the exposed person is responsive, give him or her several glasses of milk or water to drink and then induce vomiting.

GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid. The treatment recommended in Genium reference 100 (p. 529) includes the following: Maintain fluid and electrolytic balance; administer potassium chloride to replace thallium intracellularly; and use hemoperfusion and hemodialysis as warranted by the specifics of the incident. Various chelating therapies have been recommended.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate all nonessential personnel, and provide adequate ventilation. Cleanup personnel need protection against contact with and inhalation of dust (see sect. 8). Prevent skin contact. Scoop up spilled thallium into suitable containers for disposal. Carefully sweep or vacuum up small spills or residues without creating dust.

Waste Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Consider recycling. Follow Federal, state, and local regulations.

OSHA Designations

Air Contaminant (29 CFR 1910.1000 Subpart Z, for soluble thallium compounds as TI)

EPA Designations (40 CFR 302.4)

RCRA Hazardous Waste: Listed without Number

CERCLA Hazardous Substance, Reportable Quantity: 1000 lbs (454 kg)

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Follow the eye- and face-protection guidelines in 29 CFR 1910.133. **Respirator:** Wear a NIOSH-approved respirator per the *NIOSH Pocket Guide to Chemical Hazards* for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow the respirator guidelines in 29 CFR 1910.134. For emergency or nonroutine use (e.g., cleaning reactor vessels or storage tanks), wear an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres.

Other: Wear impervious gloves; boots; aprons; and clean, impervious, body-covering clothing to prevent any possibility of skin contact. Barrier creams may be useful to limit the effects of skin contact.

Ventilation: Install and operate general and local ventilation systems powerful enough to maintain airborne levels of thallium below the OSHA PEL standard cited in section 2.

Safety Stations: Make eyewash stations, washing facilities, and safety showers available in use and handling areas.

Contaminated Equipment: Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Particles can adhere to contact lenses and cause corneal damage. Do *not* wear contact lenses in any work area.

Comments: Practice good personal hygiene; always wash thoroughly after using this material. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store thallium metal in a cool, dry, well-ventilated area in closed containers away from oxidizing agents, fluorine, and sources of ignition.

Special Handling/Storage: Practice good housekeeping techniques that minimize accumulation of dust; cleaning procedures should not create dusty conditions.

Transportation Data (49 CFR 172.101-2):

DOT Shipping Name: Thallium Salt, Solid, NOS

DOT Label: Poison

IMO Label: Poison or St. Andrew's Cross (X)*

DOT ID Nos. UN1707; NA1707

DOT Class: Poison B

IMO Class: 6.1

*Harmful-Stow away from Foodstuffs (IMO Label, Materials of Class 6.1 Packaging Group III).

References: 1, 2, 12, 73, 84-94, 100, 103.

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Prepared by PJ Igoe, BS

Industrial Hygiene Review: DJ Wilson, CIH

Medical Review: MJ Hardies, MD



Genium Publishing Corporation

1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 73
Zinc Metal/Powder

Issued: 7/80

Revision: A, 11/89

30

Section 1. Material Identification

Zinc Metal/Powder Description: A metallic element extracted from ores which are first roasted to form zinc oxide and then: 1) the zinc oxide is leached from the roasted material with sulfuric acid to form a zinc sulfate solution which is electrolyzed in cells to deposit zinc on cathodes and 2) the zinc oxide is reduced with carbon in retorts (distilling vessels) to yield distilled and condensed zinc. Used as ingredient in alloys such as brass, bronze, and die-casting alloys; galvanizing sheet iron; for electrical apparatus, especially castings, building materials, dry cell batteries, automotive equipment, household utensils, railroad car linings; as a fungicide; in nutrition (essential growth element); as reagent in analytical chemistry; in bleaching bone glue, manufacturing sodium hydrosulfite, and insulin zinc salts.

Other Designations: Blue powder; spelter; granular zinc; jasad; merrillite; pasco; Zn; CAS No. 7440-66-6.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.

R 1
I 1
S 1
K 1

NFPA



HMIS

H 0

F 1

R 1

PPG*

* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Zinc metal/powder, ca 99%

OSHA PEL

None established*

ACGIH TLV, 1989-90

None established*

NIOSH REL, 1987

None established*

Toxicity Data†

Human, inhalation, TC_{50} : 124 mg/m³/50 min,
pulmonary system effects

* The current OSHA standard and ACGIH (1989-1990) TWA for zinc oxide (ZnO) fumes is 5 mg/m³. The ACGIH TWA for zinc oxide dust is 10 mg/m³, providing that total contains no asbestos and is <1% crystalline silica. NIOSH has recommended a 10-hr TWA of 5 mg/m³ and a ceiling level of 15 mg/m³ (15-min sample) for zinc oxide fume. The TLV-TWA level was set to prevent metal fume fever.

† See NIOSH, *RTECS* (ZG8600000), for additional data with references to irritative effects.

Section 3. Physical Data

Boiling Point: 907 °F (1663 °C)

Atomic Weight: 65.37 g/mol

Melting Point: 419 °F (787 °C)

Specific Gravity ($H_2O = 1$ at 39 °F (4 °C)): 7.13 at 77 °F (25 °C)

Vapor Pressure: 1 mm Hg at 909 °F (487 °C)

Water Solubility: Insoluble

Brinell Hardness: 31

Index of Explosibility, Zn Powder (<0.1 weak, >10 severe): 0.1

Appearance and Odor: Bluish-white lustrous metal, also finely divided forms.

Section 4. Fire and Explosion Data

Flash Point: None reported

Autoignition Temperature: Cloud, 1256 °F (680 °C);* dust layer,
860 °F (460 °C);* powder, 650 mJ*

LEL: Dust cloud explosion,
0.5 oz/ft³

UEL: None reported

Extinguishing Media: Use special dry chemical or clean dry sand. *Never* use CO_2 . Using a direct stream of water may scatter the fire or disperse dust, creating a potentially explosive mixture if exposed to heat or ignition sources. A water spray may be used to cool fire-exposed containers and disperse vapors.

Unusual Fire or Explosion Hazards: Flammable hydrogen gas is liberated by reaction with alkali hydroxides (sodium, potassium, and calcium hydroxides), acids, or even water (when material is in dust form) and is an explosion hazard in a confined space. In a fire, zinc may melt, vaporize, and burn to form ZnO fumes (Sec. 2).

Special Fire-fighting Procedures: For major fires, or if large quantities of this material are involved, fire fighters should wear appropriate protective clothing and respiratory protection. Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

* Zinc dust refers to the product of zinc vapor condensation, and zinc powder to the product of molten zinc atomization (*Zinc Dust and Zinc Powder: Their Production, Properties, and Applications*, B.C. Hafford, W.E. Pepper, and T.B. Lloyd, 1982). Dust 100% thru 74- μ m sieve; a 0.96-J spark can ignite a cloud. The ignition temperature in CO_2 is 896 °F (480 °C). The reaction temperature in a nitrogen atmosphere is 1112 °F (600 °C).

Section 5. Reactivity Data

Stability/Polymerization: Zinc is stable in dry air at room temperature. Moist zinc dust can react exothermically and ignite spontaneously in air. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Zinc dust is an explosion hazard when reacted with acids, chlorates, oxidizing agents (sulfur and oxygen), halogenated hydrocarbons, hydrazine mononitrate, hydroxylamine, ammonium nitrate, barium dioxide, barium nitrate, cadmium, performic acid, manganese chloride, nitric acid, ethyl acetoacetate and tribromoneopentyl alcohol, tellurium, carbon disulfide, lead azide, magnesium and barium nitrate and barium dioxide, selenium, sodium peroxide, potassium nitrate, and water. In humans, a toxic effect results from inhaling 124 mg/m³ of zinc metal/powder for 50 min.

Hazardous Products of Decomposition: Thermal oxidative decomposition of zinc can produce highly toxic fumes. Above 999 °F (537 °C) vaporized zinc burns in air with a blue-green flame to produce zinc oxide fumes.

Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists zinc as a carcinogen.

Summary of Risks: Zinc is relatively nontoxic, but when combined with other materials such as oxygen or mineral acids, the resulting compounds can have toxic effects. It is not readily absorbed through the skin, gastrointestinal (GI) tract, or lungs. Although most inorganic zinc compounds are potential causes of gastroenteric irritation, a high-level dose is relatively nontoxic when ingested. Zinc is considered essential to life. Ingestion of soluble salts may cause nausea and vomiting, sluggishness, and light-headedness. Inhalation of zinc fumes normally generated by zinc and extreme heat may cause *metal fume fever*, which is accompanied by throat dryness and irritation, coughing, weakness, dyspnea, and generalized aching that generally passes within 24 hr. These symptoms usually begin 3 to 10 hr after exposure and resolve within 24 to 48 hr. Inhalation of zinc dust may cause mild irritation to the upper respiratory tract. Prolonged skin contact with zinc may cause a mild, drying dermatitis.

Medical Conditions Aggravated by Long-Term Exposure: Since metallic zinc particulates can be considered a nuisance dust, repeated inhalation of zinc dust could lead to respiratory complications.

Target Organs: Respiratory system.

Primary Entry: Inhalation, ingestion.

Acute Effects: Metal fume fever is an acute, self-limiting condition, without recognized complications, aftereffects, or chronic forms. Symptoms appear several hours after exposure. Removal from exposure normally alleviates symptoms with no residual or chronic effects. A degree of tolerance may result from continued exposure, but is quickly lost after a day or two of nonexposure.

Chronic Effects: Zinc and zinc powder have little history of causing chronic effects.

FIRST AID

Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.

Skin: After rinsing affected area with flooding amounts of water, wash it with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that conscious person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear. **Physician's Note:** Calcium disodium edetate (CaNa₂-EDTA) has been used medically to increase the rate of zinc removal from the body; however, this usually results from chronic fume exposure or exposure to zinc salts, not to zinc metal powders.

After first aid, get appropriate in-plant, paramedic, or community medical attention and support.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of powder spills. Eliminate all heat and ignition sources. Cleanup personnel should protect against dust inhalation and eye contact. Use nonsparking tools for cleanup. Sweep or otherwise place the spilled material in an appropriate, pressure-vented, dry-metal container (with lid) for later disposal. Container should be pressure vented. Avoid creating airborne dust conditions.

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

OSHA Designations

Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1000 lb (454 kg) [* per Clean Water Act, Sec. 307(a)]

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Zinc (fume or dust) is listed as SARA Toxic Chemical (40 CFR 372.65)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: For zinc oxide dust or fume concentrations up to 50 mg/m³ and 250 mg/m³, use, respectively, a fume (high-efficiency particulate) respirator or an air-supplied or self-contained respirator with a full facepiece. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.

Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.

Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below established TLVs-TWAs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103).

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment. Wash thoroughly before changing to street clothes.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in covered metal containers in a dry, well-ventilated, low fire risk area. Protect containers from physical damage. Never store with acids, halogenated hydrocarbons, or strong alkalis.

Engineering Controls: Avoid breathing dust or fumes. Use good housekeeping and cleaning techniques to minimize airborne particulates and to prevent dust accumulation. Provide suitable training in personal hygiene and in the cause and effect of metal fume fever. Prevent exposure of workers with respiratory problems or gastrointestinal disorders.

Transportation Data (49 CFR 172.102)

IMO Shipping Name: Zinc, powder or dust, nonpyrophoric

IMO Hazard Class: 4.3

IMO Label: Dangerous when wet

IMDG Packaging Group: II

IMO Shipping Name: Zinc, powder or dust, pyrophoric

IMO Hazard Class: 4.2

IMO Label: Spontaneously combustible

IMDG Packaging Group: II

MSDS Collection References: 2, 4-11, 24, 31, 39-41, 80, 81, 84, 85, 91, 109

Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** Warren Silverman, MD

Attachment B

29 CFR 1910.1018 OSHA Inorganic Arsenic Standard

&

**Appendix A to 29 CFR 1910.1018 OSHA
Inorganic Arsenic Substance Information Sheet**

VINYL CHLORIDE (OR TRADE NAME)

Contains

VINYL CHLORIDE

VINYL CHLORIDE IS A CANCER-SUSPECT AGENT
Containers of vinyl chloride shall be labeled either:

VINYL CHLORIDE

FLAMMABLE GAS UNDER PRESSURE

CANCER SUSPECT AGENT

In accordance with 49 CFR 180 through 189, with the addition:

CANCER-SUSPECT AGENT

near the label or placard.

Statement shall appear on or required sign, label or in which contradicts or detracts the effect of, any required warning or instruction.

Records. (1) All records maintained in accordance with this section include the name and social security number of each employee where

Records of required monitoring measuring and medical records provided upon request to designated representatives, Assistant Secretary in accordance with 29 CFR 1910.20 (a) through (g) through (i). These records provided upon request to the authorized personnel rosters be provided upon request to Assistant Secretary and the Director

Monitoring and measuring shall:

State the date of such monitoring-measuring and the concentration determined and identify the instrument and methods used;

Include any additional information necessary to determine individual exposures where such exposures determined by means other than individual monitoring of employees

maintained for not less than

erved]

Occupational Safety and Health Admin., Labor

§ 1910.1018

(iii) Medical records shall be maintained for the duration of the employment of each employee plus 20 years, or 30 years, whichever is longer.

(3) In the event that the employer ceases to do business and there is no successor to receive and retain his records for the prescribed period, these records shall be transmitted by registered mail to the Director, and each employee individually notified in writing of this transfer. The employer shall also comply with any additional requirements set forth in 29 CFR 1910.20(h).

(n) Reports. (1) Not later than 1 month after the establishment of a regulated area, the following information shall be reported to the OSHA Area Director. Any changes to such information shall be reported within 15 days.

(i) The address and location of each establishment which has one or more regulated areas; and

(ii) The number of employees in each regulated area during normal operations, including maintenance.

(2) Emergencies, and the facts obtainable at that time, shall be reported within 24 hours to the OSHA Area Director. Upon request of the Area Director, the employer shall submit additional information in writing relevant to the nature and extent of employee exposures and measures taken to prevent future emergencies of similar nature.

(3) Within 10 working days following any monitoring and measuring which discloses that any employee has been exposed, without regard to the use of respirators, in excess of the permissible exposure limit, each such employee shall be notified in writing of the results of the exposure measurement and the steps being taken to reduce the exposure to within the permissible exposure limit.

(c) Effective dates. (1) Until April 1, 1975, the provisions currently set forth in § 1910.93q of this part shall apply.

(2) Effective April 1, 1975, the provisions set forth in § 1910.93q of this part shall apply.

(Approved by the Office of Management and Budget under control number 1218-0010)

APPENDIX A to § 1910.1017—SUPPLEMENTARY MEDICAL INFORMATION

When required tests under paragraph (k)(1) of this section show abnormalities, the tests should be repeated as soon as practicable, preferably within 3 to 4 weeks. If tests remain abnormal, consideration should be given to withdrawal of the employee from contact with vinyl chloride, while a more comprehensive examination is made.

Additional tests which may be useful:

A. For kidney dysfunction: urine examination for albumin, red blood cells, and exfoliative abnormal cells.

B. Pulmonary system: Forced vital capacity, Forced expiratory volume at 1 second, and chest roentgenogram (posterior-anterior, 14 x 17 inches).

C. Additional serum tests: Lactic acid dehydrogenase, lactic acid dehydrogenase isoenzyme, protein determination, and protein electrophoresis.

D. For a more comprehensive examination on repeated abnormal serum tests: Hepatitis B antigen, and liver scanning.

[39 FR 35896, Oct. 4, 1974; 39 FR 41848, Dec. 3, 1974, as amended at 40 FR 13211, Mar. 25, 1975. Redesignated at 40 FR 23072, May 23, 1975 and amended at 43 FR 49751, Oct. 24, 1978; 45 FR 35282, May 23, 1980; 54 FR 24334, June 7, 1989]

§ 1910.1018 Inorganic arsenic.

(a) Scope and application. This section applies to all occupational exposures to inorganic arsenic except that this section does not apply to employee exposures in agriculture or resulting from pesticide application, the treatment of wood with preservatives or the utilization of arsenically preserved wood.

(b) Definitions. Action level means a concentration of inorganic arsenic of 5 micrograms per cubic meter of air (5 µg/m³) averaged over any eight (8) hour period.

Assistant Secretary means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

Authorized person means any person specifically authorized by the employer whose duties require the person to enter a regulated area, or any person entering such an area as a designated representative of employees for the purpose of exercising the right to observe monitoring and measuring procedures under paragraph (e) of this section.

Director means the Director, National Institute for Occupational Safety and Health, U.S. Department of Health, Education and Welfare, or designee.

Inorganic arsenic means copper aceto-arsenite and all inorganic compounds containing arsenic except arsine, measured as arsenic (As).

(c) **Permissible exposure limit.** The employer shall assure that no employee is exposed to inorganic arsenic at concentrations greater than 10 micrograms per cubic meter of air ($10 \mu\text{g}/\text{m}^3$), averaged over any 8-hour period.

(d) **Notification of use.** (1) By October 1, 1978 or within 60 days after the introduction of inorganic arsenic into the workplace, every employer who is required to establish a regulated area in his workplaces shall report in writing to the OSHA area office for each such workplace:

- (i) The address of each such workplace;
- (ii) The approximate number of employees who will be working in regulated areas; and
- (iii) A brief summary of the operations creating the exposure and the actions which the employer intends to take to reduce exposures.

(2) Whenever there has been a significant change in the information required by paragraph (d)(1) of this section the employer shall report the changes in writing within 60 days to the OSHA area office.

(e) **Exposure monitoring—(1) General.** (i) Determinations of airborne exposure levels shall be made from air samples that are representative of each employee's exposure to inorganic arsenic over an eight (8) hour period.

(ii) For the purposes of this section, employee exposure is that exposure which would occur if the employee were not using a respirator.

(iii) The employer shall collect full shift (for at least 7 continuous hours) personal samples including at least one sample for each shift for each job classification in each work area.

(2) **Initial monitoring.** Each employer who has a workplace or work operation covered by this standard shall monitor each such workplace and work operation to accurately determine the airborne concentration of in-

organic arsenic to which employees may be exposed.

(3) **Frequency.** (i) If the initial monitoring reveals employee exposure to be below the action level the measurements need not be repeated except as otherwise provided in paragraph (e)(4) of this section.

(ii) If the initial monitoring, required by this section, or subsequent monitoring reveals employee exposure to be above the permissible exposure limit, the employer shall repeat monitoring at least quarterly.

(iii) If the initial monitoring, required by this section, or subsequent monitoring reveals employee exposure to be above the action level and below the permissible exposure limit the employer shall repeat monitoring at least every six months.

(iv) The employer shall continue monitoring at the required frequency until at least two consecutive measurements, taken at least seven (7) days apart, are below the action level at which time the employer may discontinue monitoring for that employee until such time as any of the events in paragraph (e)(4) of this section occur.

(4) **Additional monitoring.** Whenever there has been a production, process, control or personal change which may result in new or additional exposure to inorganic arsenic, or whenever the employer has any other reason to suspect a change which may result in new or additional exposures to inorganic arsenic, additional monitoring which complies with paragraph (e) of this section shall be conducted.

(5) **Employee notification.** (i) Within five (5) working days after the receipt of monitoring results, the employer shall notify each employee in writing of the results which represent that employee's exposures.

(ii) Whenever the results indicate that the representative employee exposure exceeds the permissible exposure limit, the employer shall include in the written notice a statement that the permissible exposure limit was exceeded and a description of the corrective action taken to reduce exposure to or below the permissible exposure limit.

(6) **Accuracy of measurement.** (i) The employer shall use a method of moni-

toring and measurement which has accuracy (with a confidence level of 95 percent) of not less than plus or minus 25 percent for concentrations of inorganic arsenic greater than or equal to $10 \mu\text{g}/\text{m}^3$.

(ii) The employer shall use a method of monitoring and measurement which has an accuracy (with confidence level of 95 percent) of not less than plus or minus 35 percent for concentrations of inorganic arsenic greater than $5 \mu\text{g}/\text{m}^3$ but less than $10 \mu\text{g}/\text{m}^3$.

(f) **Regulated area—(1) Establishment.** The employer shall establish regulated areas where worker exposures to inorganic arsenic, with regard to the use of respirators, are in excess of the permissible limit.

(2) **Demarcation.** Regulated areas shall be demarcated and segregated from the rest of the workplace in a manner that minimizes the number of persons who will be exposed to inorganic arsenic.

(3) **Access.** Access to regulated areas shall be limited to authorized persons or to persons otherwise authorized by the Act or regulations issued pursuant thereto to enter such areas.

(4) **Provision of respirators.** All persons entering a regulated area shall be supplied with a respirator, selected in accordance with paragraph (h)(2) of this section.

(5) **Prohibited activities.** The employer shall assure that in regulated areas, food or beverages are not consumed, smoking products, chewing tobacco and gum are not used and cosmetics are not applied, except that these activities may be conducted in the lunchrooms, change rooms and showers required under paragraph (i) of this section. Drinking water may be consumed in the regulated area.

(g) **Methods of compliance—(1) Controls.** (i) The employer shall institute controls at the earliest possible time but not later than December 31, 1979, engineering and work practice controls to reduce exposures to or below the permissible exposure limit, except to the extent that the employer can establish that such controls are not feasible.

(ii) Where engineering and work practice controls are not sufficient to reduce exposures to or below the permissible exposure limit, they shall

arsenic to which employees are exposed.

Frequency. (i) If the initial monitoring reveals employee exposure to be above the action level the measurement need not be repeated except as provided in paragraph (e)(4) of this section.

If the initial monitoring, required by this section, or subsequent monitoring reveals employee exposure above the permissible exposure limit the employer shall repeat monitoring at least quarterly.

If the initial monitoring, required by this section, or subsequent monitoring reveals employee exposure above the action level and below the permissible exposure limit the employer shall repeat monitoring at least six months.

The employer shall continue monitoring at the required frequency until two consecutive measurements taken at least seven (7) days are below the action level at which time the employer may discontinue monitoring for that employee at any time as any of the events in paragraph (e)(4) of this section occur.

Additional monitoring. Whenever there has been a production, control or personal change that may result in new or additional exposure to inorganic arsenic, or whenever the employer has any other reason to suspect a change which may result in new or additional exposures to inorganic arsenic, additional monitoring which complies with paragraph (e) of this section shall be conducted.

Employee notification. (i) Within 10 working days after the receipt of monitoring results, the employer shall notify each employee in writing of the results which represent that employee's exposures.

Whenever the results indicate that a representative employee exposure exceeds the permissible exposure limit, the employer shall include in the written notice a statement that the permissible exposure limit was exceeded and a description of the corrective action taken to reduce exposure to or below the permissible exposure limit.

Accuracy of measurement. (i) The employer shall use a method of monitoring and measurement which has an accuracy (with a confidence level of 95 percent) of not less than plus or minus 25 percent for concentrations of inorganic arsenic greater than or equal to 10 µg/m³.

(ii) The employer shall use a method of monitoring and measurement which has an accuracy (with a confidence level of 95 percent) of not less than plus or minus 35 percent for concentrations of inorganic arsenic greater than 5 µg/m³ but less than 10 µg/m³.

(f) **Regulated area.** (1) **Establishment.** The employer shall establish regulated areas where worker exposures to inorganic arsenic, without regard to the use of respirators, are in excess of the permissible limit.

(2) **Demarcation.** Regulated areas shall be demarcated and segregated from the rest of the workplace in any manner that minimizes the number of persons who will be exposed to inorganic arsenic.

(3) **Access.** Access to regulated areas shall be limited to authorized persons or to persons otherwise authorized by the Act or regulations issued pursuant thereto to enter such areas.

(4) **Provision of respirators.** All persons entering a regulated area shall be supplied with a respirator, selected in accordance with paragraph (h)(2) of this section.

(5) **Prohibited activities.** The employer shall assure that in regulated areas, food or beverages are not consumed, smoking products, chewing tobacco and gum are not used and cosmetics are not applied, except that these activities may be conducted in the lunchrooms, change rooms and showers required under paragraph (m) of this section. Drinking water may be consumed in the regulated area.

(g) **Methods of compliance.** (1) **Controls.** (i) The employer shall institute at the earliest possible time but not later than December 31, 1979, engineering and work practice controls to reduce exposures to or below the permissible exposure limit, except to the extent that the employer can establish that such controls are not feasible.

(ii) Where engineering and work practice controls are not sufficient to reduce exposures to or below the permissible exposure limit, they shall

nonetheless be used to reduce exposures to the lowest levels achievable by these controls and shall be supplemented by the use of respirators in accordance with paragraph (h) of this section and other necessary personal protective equipment. Employee rotation is not required as a control strategy before respiratory protection is instituted.

(2) **Compliance Program.** (i) The employer shall establish and implement a written program to reduce exposures to or below the permissible exposure limit by means of engineering and work practice controls.

(ii) Written plans for these compliance programs shall include at least the following:

(A) A description of each operation in which inorganic arsenic is emitted; e.g. machinery used, material processed, controls in place, crew size, operating procedures and maintenance practices;

(B) Engineering plans and studies used to determine methods selected for controlling exposure to inorganic arsenic;

(C) A report of the technology considered in meeting the permissible exposure limit;

(D) Monitoring data;

(E) A detailed schedule for implementation of the engineering controls and work practices that cannot be implemented immediately and for the adaption and implementation of any additional engineering and work practices necessary to meet the permissible exposure limit;

(F) Whenever the employer will not achieve the permissible exposure limit with engineering controls and work practices by December 31, 1979, the employer shall include in the compliance plan an analysis of the effectiveness of the various controls, shall install engineering controls and institute work practices on the quickest schedule feasible, and shall include in the compliance plan and implement a program to minimize the discomfort and maximize the effectiveness of respirator use; and

(G) Other relevant information.

(iii) Written plans for such a program shall be submitted upon request to the Assistant Secretary and the Director.

rector, and shall be available at the worksite for examination and copying by the Assistant Secretary, Director, any affected employee or authorized employee representatives.

(iv) The plans required by this paragraph shall be revised and updated at least every 6 months to reflect the current status of the program.

(h) **Respiratory protection**—(1) **General**. The employer shall assure that respirators are used where required under this section to reduce employee exposures to below the permissible exposure limit and in emergencies. Respirators shall be used in the following circumstances:

(i) During the time period necessary to install or implement feasible engineering or work practice controls;

(ii) In work operations such as maintenance and repair activities in which the employer establishes that engineering and work practice controls are not feasible;

(iii) In work situations in which engineering controls and supplemental

work practice controls are not yet sufficient to reduce exposures to or below the permissible exposure limit; or

(iv) In emergencies.

(2) **Respirator selection**. (i) Where respirators are required under this section the employer shall select, provide at no cost to the employee and assure the use of the appropriate respirator or combination of respirators from Table I below for inorganic arsenic compounds without significant vapor pressure, or Table II below for inorganic arsenic compounds which have significant vapor pressure.

(ii) Where employee exposures exceed the permissible exposure limit for inorganic arsenic and also exceed the relevant limit for particular gasses such as sulfur dioxide, any air purifying respirator supplied to the employee as permitted by this standard must have a combination high efficiency filter with an appropriate gas sorbent. (See footnote in Table I)

TABLE I—RESPIRATORY PROTECTION FOR INORGANIC ARSENIC PARTICULATE EXCEPT FOR THOSE WITH SIGNIFICANT VAPOR PRESSURE

Concentration of inorganic arsenic (as As) or condition of use	Required respirator
(i) Unknown or greater or lesser than 20,000 $\mu\text{g}/\text{m}^3$ (20 mg/m ³) or firefighting.	(A) Any full facepiece self-contained breathing apparatus operated in positive pressure mode.
(ii) Not greater than 20,000 $\mu\text{g}/\text{m}^3$ (20 mg/m ³)	(A) Supplied air respirator with full facepiece, hood, or helmet or suit and operated in positive pressure mode.
(iii) Not greater than 10,000 $\mu\text{g}/\text{m}^3$ (10 mg/m ³)	(A) Powered air-purifying respirators in all inlet face coverings with high efficiency filters. ¹ (B) Half-mask supplied air respirators operated in positive pressure mode.
(iv) Not greater than 500 $\mu\text{g}/\text{m}^3$	(A) Full facepiece air-purifying respirator equipped with high-efficiency filter. ¹ (B) Any full facepiece supplied air respirator. (C) Any full facepiece self-contained breathing apparatus.
(v) Not greater than 100 $\mu\text{g}/\text{m}^3$	(A) Half-mask air-purifying respirator equipped with high-efficiency filter. ¹ (B) Any half-mask supplied air respirator.

¹High-efficiency filter—99.97 pct efficiency against 0.3 micrometer monodisperse diethyl-hexyl phthalate (DOP) particles.

TABLE II—RESPIRATORY PROTECTION FOR INORGANIC ARSENICALS (SUCH AS ARSENIC TRICHLORIDE² and Arsenic Phosphide) With Significant Vapor Pressure

Concentration of inorganic arsenic (as As) or condition of use	Required respirator
(i) Unknown or greater or lesser than 20,000 $\mu\text{g}/\text{m}^3$ (20mg/m ³) or firefighting.	(A) Any full facepiece self-contained breathing apparatus operated in positive pressure mode.
(ii) Not greater than 20,000 $\mu\text{g}/\text{m}^3$ (20 mg/m ³)	(A) Supplied air respirator with full facepiece hood, or helmet or suit and operated in positive pressure mode.
(iii) Not greater than 10,000 $\mu\text{g}/\text{m}^3$ (10mg/m ³)	(A) Half-mask ² supplied air respirator operated in positive pressure mode.
(iv) Not greater than 500 $\mu\text{g}/\text{m}^3$	(A) Front or back mounted gas mask equipped with high-efficiency filter ¹ and acid gas canister. (B) Any full facepiece supplied air respirator. (C) Any full facepiece self-contained breathing apparatus.

TABLE II—RESPIRATORY PROTECTION FOR TRICHLORIDE² and Arsenic Phosphide)

Concentration of inorganic arsenic (as As) or condition of use	
(v) Not greater than 100 $\mu\text{g}/\text{m}^3$	(A) Half-mask and 1

¹High efficiency filter—99.97 pct efficiency against 0.3 micrometer monodisperse diethyl-hexyl phthalate (DOP) particles.
²Half-mask respirators shall not be used for protection against

(iii) The employer shall select respirators from among those approved for protection against dust, fume, and mist by the National Institute for Occupational Safety and Health (NIOSH) under the provisions of 3 CFR Part 11.

(3) **Respirator usage**. (i) The employer shall assure that the respirator issued to the employee exhibits minimum facepiece leakage and that the respirator is fitted properly.

(ii) The employer shall perform qualitative fit tests at the time of initial fitting and at least semi-annual thereafter for each employee wearing respirators, where quantitative fit tests are not required.

(iii) Employers with more than 10 employees wearing respirators shall perform a quantitative face fit test at the time of initial fitting and at least semi-annually thereafter for each employee wearing negative pressure respirators. The test shall be used to select facepieces that provide the required protection as prescribed in Table I or II.

(iv) If an employee has demonstrated difficulty in breathing during a fitting test or during use, he or she shall be examined by a physician trained in pulmonary medicine to determine whether the employee should wear a respirator while performing the required duty.

(4) **Respirator program**. (i) The employer shall institute a respiratory protection program in accordance with 29 CFR 1910.134 (b), (d), (e) and (f).

(ii) The employer shall permit an employee who uses a filter respirator to change the filter elements whenever an increase in breathing resistance is detected and shall maintain adequate supply of filter elements for this purpose.

controls are not yet sufficient to reduce exposures to or below the permissible exposure limit; or in emergencies.

R Respirator selection. (i) Where respirators are required under this section, the employer shall select, provide, and fit the employee and assure the appropriate respirator selection of respirators from those listed in Table II below for inorganic arsenic compounds without significant vapor pressure.

(ii) Where employee exposures are at or below the permissible exposure limit for inorganic arsenic and also exceed the permissible exposure limit for carbon dioxide, any air purifying respirator supplied to the employee must be a combination high efficiency respirator with an appropriate gas sorbent (see Table I).

C PARTICULATE EXCEPT FOR THOSE WITH SIGNIFICANT VAPOR PRESSURE

Required respirator

(i) Maintained breathing apparatus operated in full facepiece, hood, or helmet or suit and pressure mode.

(ii) Respirators in all inlet face coverings with high efficiency filter supplied air respirators operated in negative pressure mode.

(iii) Respirator equipped with high-efficiency filter supplied air respirator. (C) Any full facepiece apparatus.

(iv) Respirator equipped with high-efficiency filter supplied air respirator.

(v) Respirator equipped with high-efficiency filter supplied air respirator. (C) Any full facepiece apparatus.

INORGANIC ARSENICALS (SUCH AS ARSENIC TRICHLORIDE) WITH SIGNIFICANT VAPOR PRESSURE

Required respirator

(i) Maintained breathing apparatus operated in full facepiece hood, or helmet or suit and pressure mode.

(ii) Respirators in all inlet face coverings with high efficiency filter supplied air respirators operated in negative pressure mode.

(iii) Respirator equipped with high-efficiency filter supplied air respirator. (C) Any full facepiece apparatus.

(iv) Respirator equipped with high-efficiency filter supplied air respirator.

Occupational Safety and Health Admin., Labor

§ 1910.1018

TABLE II—RESPIRATORY PROTECTION FOR INORGANIC ARSENICALS (SUCH AS ARSENIC TRICHLORIDE¹ and Arsenic Phosphide) With Significant Vapor Pressure—Continued

Concentration of inorganic arsenic (as As) or condition of use	Required respirator
(v) Not greater than 100 µg/m ³	(A) Half-mask ² air-purifying respirator equipped with high-efficiency filter ¹ and acid gas cartridge. (B) Any half-mask supplied air respirator.

¹High efficiency filter—99.97 pct efficiency against 0.3 micrometer monodisperse diethyl-hexyl phthalate (DOP) particles.
²Half-mask respirators shall not be used for protection against arsenic trichloride, as it is rapidly absorbed through the skin.

(iii) The employer shall select respirators from among those approved for protection against dust, fume, and mist by the National Institute for Occupational Safety and Health (NIOSH) under the provisions of 30 CFR Part 11.

(3) **Respirator usage.** (i) The employer shall assure that the respirator issued to the employee exhibits minimum facepiece leakage and that the respirator is fitted properly.

(ii) The employer shall perform qualitative fit tests at the time of initial fitting and at least semi-annually thereafter for each employee wearing respirators, where quantitative fit tests are not required.

(iii) Employers with more than 20 employees wearing respirators shall perform a quantitative face fit test at the time of initial fitting and at least semi-annually thereafter for each employee wearing negative pressure respirators. The test shall be used to select facepieces that provide the required protection as prescribed in Table I or II.

(iv) If an employee has demonstrated difficulty in breathing during the fitting test or during use, he or she shall be examined by a physician trained in pulmonary medicine to determine whether the employee can wear a respirator while performing the required duty.

(4) **Respirator program.** (i) The employer shall institute a respiratory protection program in accordance with 29 CFR 1910.134 (b), (d), (e) and (f).

(ii) The employer shall permit each employee who uses a filter respirator to change the filter elements whenever an increase in breathing resistance is detected and shall maintain an adequate supply of filter elements for this purpose.

(iii) Employees who wear respirators shall be permitted to leave work areas to wash their face and respirator facepiece to prevent skin irritation associated with respirator use.

(5) **Commencement of respirator use.**

(i) The employer's obligation to provide respirators commences on August 1, 1978 for employees exposed over 500 µg/m³ of inorganic arsenic, as soon as possible but not later than October 1, 1978 for employees exposed to over 50 µg/m³ of inorganic arsenic, and as soon as possible but not later than December 1, 1978 for employees exposed between 10 and 50 µg/m³ of inorganic arsenic.

(ii) Employees with exposures below 50 µg/m³ of inorganic arsenic may choose not to wear respirators until December 31, 1979.

(iii) After December 1, 1978 any employee required to wear air-purifying respirators may choose, and if so chosen the employer must provide, if it will give proper protection, a powered air purifying respirator and in addition if necessary a combination dust and acid gas respirator for times where exposures to gases are over the relevant exposure limits.

(i) [Reserved]

(j) **Protective work clothing and equipment—(1) Provision and use.** Where the possibility of skin or eye irritation from inorganic arsenic exists, and for all workers working in regulated areas, the employer shall provide at no cost to the employee and assure that employees use appropriate and clean protective work clothing and equipment such as, but not limited to:

(i) Coveralls or similar full-body work clothing;

(ii) Gloves, and shoes or coverlets;

(iii) Face shields or vented goggles when necessary to prevent eye irrita-

tion, which comply with the requirements of § 1910.133(a) (2)-(6); and

(iv) Impervious clothing for employees subject to exposure to arsenic trichloride.

(2) *Cleaning and replacement.* (i) The employer shall provide the protective clothing required in paragraph (j) (1) of this section in a freshly laundered and dry condition at least weekly, and daily if the employee works in areas where exposures are over 100 $\mu\text{g}/\text{m}^3$ of inorganic arsenic or in areas where more frequent washing is needed to prevent skin irritation.

(ii) The employer shall clean, launder, or dispose of protective clothing required by paragraph (j) (1) of this section.

(iii) The employer shall repair or replace the protective clothing and equipment as needed to maintain their effectiveness.

(iv) The employer shall assure that all protective clothing is removed at the completion of a work shift only in change rooms prescribed in paragraph (m) (1) of this section.

(v) The employer shall assure that contaminated protective clothing which is to be cleaned, laundered, or disposed of, is placed in a closed container in the change-room which prevents dispersion of inorganic arsenic outside the container.

(vi) The employer shall inform in writing any person who cleans or launders clothing required by this section, of the potentially harmful effects including the carcinogenic effects of exposure to inorganic arsenic.

(vii) The employer shall assure that the containers of contaminated protective clothing and equipment in the workplace or which are to be removed from the workplace are labelled as follows:

CAUTION: Clothing contaminated with inorganic arsenic; do not remove dust by blowing or shaking. Dispose of inorganic arsenic contaminated wash water in accordance with applicable local, State or Federal regulations.

(viii) The employer shall prohibit the removal of inorganic arsenic from protective clothing or equipment by blowing or shaking.

(k) *Housekeeping*—(1) *Surfaces.* All surfaces shall be maintained as free as practicable of accumulations of inorganic arsenic.

(2) *Cleaning floors.* Floors and other accessible surfaces contaminated with inorganic arsenic may not be cleaned by the use of compressed air, and shoveling and brushing may be used only where vacuuming or other relevant methods have been tried and found not to be effective.

(3) *Vacuuming.* Where vacuuming methods are selected, the vacuums shall be used and emptied in a manner to minimize the reentry of inorganic arsenic into the workplace.

(4) *Housekeeping plan.* A written housekeeping and maintenance plan shall be kept which shall list appropriate frequencies for carrying out housekeeping operations, and for cleaning and maintaining dust collection equipment. The plan shall be available for inspection by the Assistant Secretary.

(5) *Maintenance of equipment.* Periodic cleaning of dust collection and ventilation equipment and checks of their effectiveness shall be carried out to maintain the effectiveness of the system and a notation kept of the last check of effectiveness and cleaning or maintenance.

(l) [Reserved]

(m) *Hygiene facilities and practices*—(1) *Change rooms.* The employer shall provide for employees working in regulated areas or subject to the possibility of skin or eye irritation from inorganic arsenic, clean change rooms equipped with storage facilities for street clothes and separate storage facilities for protective clothing and equipment in accordance with 29 CFR 1910.141(e).

(2) *Showers.* (i) The employer shall assure that employees working in regulated areas or subject to the possibility of skin or eye irritation from inorganic arsenic shower at the end of the work shift.

(ii) The employer shall provide shower facilities in accordance with § 1910.141(d)(3).

(3) *Lunchrooms.* (i) The employer shall provide for employees working in regulated areas, lunchroom facilities which have a temperature controlled, positive pressure, filtered air supply,

and which are readily accessible to employees working in regulated areas.

(ii) The employer shall assure that employees working in the regulated area or subject to the possibility of skin or eye irritation from exposure to inorganic arsenic wash their hair and face prior to eating.

(4) *Lavatories.* The employer shall provide lavatory facilities which comply with § 1910.141(d) (1) and (2).

(5) *Vacuuming clothes.* The employer shall provide facilities for employees working in areas where exposure without regard to the use of respirators, exceeds 100 $\mu\text{g}/\text{m}^3$ to vacuum their protective clothing and clean change shoes worn in such areas before entering change rooms, luncheon rooms or shower rooms required by paragraph (j) of this section and shall assure that such employees use such facilities.

(6) *Avoidance of skin irritation.* The employer shall assure that no employee is exposed to skin or eye contact with arsenic trichloride, or to skin eye contact with liquid or particulate inorganic arsenic which is likely to cause skin or eye irritation.

(n) *Medical surveillance*—(1) *General*—(i) *Employees covered.* The employer shall institute a medical surveillance program for the following employees:

(A) All employees who are or will be exposed above the action level, without regard to the use of respirators, less than 30 days per year; and

(B) All employees who have been exposed above the action level, without regard to respirator use, for 30 days or more per year for a total of 10 years or more of combined employment with the employer or predecessor employers prior to or after the effective date of this standard. The determination of exposures prior to the effective date of this standard shall be based on prior exposure records, compared with the first measurements taken after the effective date of this standard, or comparison with records of exposures in areas with similar processes, extent of engineering controls utilized and materials used by that employer.

(ii) *Examination by physician.* The employer shall assure that all me-

Cleaning.—(1) *Surfaces.* All surfaces shall be maintained as free as possible of accumulations of inorganic arsenic.

Cleaning floors. Floors and other surfaces contaminated with inorganic arsenic may not be cleaned with the use of compressed air, and sweeping and brushing may be used. Vacuuming or other methods have been tried and found to be effective.

Vacuuming. Where vacuuming is selected, the vacuums used and emptied in a manner to minimize the reentry of inorganic arsenic to the workplace.

Cleaning plan. A written cleaning and maintenance plan shall be kept which shall list appropriate procedures for carrying out housekeeping, and for cleaning and dust collection equipment. The plan shall be available for review by the Assistant Secretary. **Maintenance of equipment.** Periodic cleaning of dust collection and other equipment and checks of effectiveness shall be carried out to maintain the effectiveness of the equipment. A notation kept of the last cleaning and effectiveness and cleaning or maintenance.

Change rooms. The employer shall provide for employees working in regulated areas or subject to the possibility of skin or eye irritation from inorganic arsenic, clean change rooms equipped with storage facilities for protective clothing and in accordance with 29 CFR

Shower. (i) The employer shall provide that employees working in regulated areas or subject to the possibility of skin or eye irritation from inorganic arsenic shower at the end of the shift.

(ii) The employer shall provide facilities in accordance with paragraph (3).

Lunchrooms. (i) The employer shall provide for employees working in regulated areas, lunchroom facilities which shall be a temperature controlled, pressure, filtered air supply,

and which are readily accessible to employees working in regulated areas.

(ii) The employer shall assure that employees working in the regulated area or subject to the possibility of skin or eye irritation from exposure to inorganic arsenic wash their hands and face prior to eating.

(4) *Lavatories.* The employer shall provide lavatory facilities which comply with § 1910.141(d) (1) and (2).

(5) *Vacuuming clothes.* The employer shall provide facilities for employees working in areas where exposure, without regard to the use of respirators, exceeds 100 $\mu\text{g}/\text{m}^3$ to vacuum their protective clothing and clean or change shoes worn in such areas before entering change rooms, lunchrooms or shower rooms required by paragraph (j) of this section and shall assure that such employees use such facilities.

(6) *Avoidance of skin irritation.* The employer shall assure that no employee is exposed to skin or eye contact with arsenic trichloride, or to skin or eye contact with liquid or particulate inorganic arsenic which is likely to cause skin or eye irritation.

(n) *Medical surveillance.*—(1) *General.*—(i) *Employees covered.* The employer shall institute a medical surveillance program for the following employees:

(A) All employees who are or will be exposed above the action level, without regard to the use of respirators, at least 30 days per year; and

(B) All employees who have been exposed above the action level, without regard to respirator use, for 30 days or more per year for a total of 10 years or more of combined employment with the employer or predecessor employers prior to or after the effective date of this standard. The determination of exposures prior to the effective date of this standard shall be based upon prior exposure records, comparison with the first measurements taken after the effective date of this standard, or comparison with records of exposures in areas with similar processes, extent of engineering controls utilized and materials used by that employer.

(ii) *Examination by physician.* The employer shall assure that all medical

examinations and procedures are performed by or under the supervision of a licensed physician, and shall be provided without cost to the employee, without loss of pay and at a reasonable time and place.

(2) *Initial examinations.* By December 1, 1978, for employees initially covered by the medical provisions of this section, or thereafter at the time of initial assignment to an area where the employee is likely to be exposed over the action level at least 30 days per year, the employer shall provide each affected employee an opportunity for a medical examination, including at least the following elements:

(i) A work history and a medical history which shall include a smoking history and the presence and degree of respiratory symptoms such as breathlessness, cough, sputum production and wheezing.

(ii) A medical examination which shall include at least the following:

(A) A 14" by 17" posterior-anterior chest X-ray and International Labor Office: UICC/Cincinnati (ILO U/C) rating;

(B) A nasal and skin examination;

(C) A sputum cytology examination; and

(D) Other examinations which the physician believes appropriate because of the employee's exposure to inorganic arsenic or because of required respirator use.

(3) *Periodic examinations.* (i) The employer shall provide the examinations specified in paragraphs (n)(2)(i) and (n)(2)(ii) (A), (B), and (D) at least annually for covered employees who are under 45 years of age with fewer than 10 years of exposure over the action level without regard to respirator use.

(ii) The employer shall provide the examinations specified in paragraphs (n)(2)(i) and (n)(2)(ii) of this section at least semi-annually for other covered employees.

(iii) Whenever a covered employee has not taken the examinations specified in paragraphs (n)(2)(i) and (n)(2)(ii) of this section within six (6) months preceding the termination of employment, the employer shall provide such examinations to the employee upon termination of employment.

(4) *Additional examinations.* If the employee for any reason develops signs or symptoms commonly associated with exposure to inorganic arsenic the employer shall provide an appropriate examination and emergency medical treatment.

(5) *Information provided to the physician.* The employer shall provide the following information to the examining physician:

(i) A copy of this standard and its appendices;

(ii) A description of the affected employee's duties as they relate to the employee's exposure;

(iii) The employee's representative exposure level or anticipated exposure level;

(iv) A description of any personal protective equipment used or to be used; and

(v) Information from previous medical examinations of the affected employee which is not readily available to the examining physician.

(6) *Physician's written opinion.* (i) The employer shall obtain a written opinion from the examining physician which shall include:

(A) The results of the medical examination and tests performed;

(B) The physician's opinion as to whether the employee has any detected medical conditions which would place the employee at increased risk of material impairment of the employee's health from exposure to inorganic arsenic;

(C) Any recommended limitations upon the employee's exposure to inorganic arsenic or upon the use of protective clothing or equipment such as respirators; and

(D) A statement that the employee has been informed by the physician of the results of the medical examination and any medical conditions which require further explanation or treatment.

(ii) The employer shall instruct the physician not to reveal in the written opinion specific findings or diagnoses unrelated to occupational exposure.

(iii) The employer shall provide a copy of the written opinion to the affected employee.

(7) *Employee information and training.* (1) *Training program.* (i) The

employer shall institute a training program for all employees who are subject to exposure to inorganic arsenic above the action level without regard to respirator use, or for whom there is the possibility of skin or eye irritation from inorganic arsenic. The employer shall assure that those employees participate in the training program.

(ii) The training program shall be provided by October 1, 1978, for employees covered by this provision, at the time of initial assignment for those subsequently covered by this provision, and shall be repeated at least quarterly for employees who have optional use of respirators and at least annually for other covered employees thereafter; and the employer shall assure that each employee is informed of the following:

(A) The information contained in Appendix A;

(B) The quantity, location, manner of use, storage, sources of exposure, and the specific nature of operations which could result in exposure to inorganic arsenic as well as any necessary protective steps;

(C) The purpose, proper use, and limitation of respirators;

(D) The purpose and a description of the medical surveillance program as required by paragraph (n) of this section;

(E) The engineering controls and work practices associated with the employee's job assignment; and

(F) A review of this standard.

(2) *Access to training materials.* (i) The employer shall make readily available to all affected employees a copy of this standard and its appendices.

(ii) The employer shall provide; upon request, all materials relating to the employee information and training program to the Assistant Secretary and the Director.

(p) *Signs and labels.* (1) *General.* (i) The employer may use labels or signs required by other statutes, regulations, or ordinances in addition to, or in combination with, signs and labels required by this paragraph.

(ii) The employer shall assure that no statement appears on or near any sign or label required by this para-

graph which contradicts or detracts from the meaning of the required sign or label.

(2) *Signs.* (i) The employer shall signs demarcating regulated areas bearing the legend:

DANGER

INORGANIC ARSENIC

CANCER HAZARD

AUTHORIZED PERSONNEL ONLY

NO SMOKING OR EATING

RESPIRATOR REQUIRED

(ii) The employer shall assure that signs required by this paragraph are illuminated and cleaned as necessary so that the legend is readily visible.

(3) *Labels.* The employer shall place precautionary labels to all shipping and storage containers of inorganic arsenic, and to all products containing inorganic arsenic except when the inorganic arsenic in the product is bound in such a manner so as to make unlikely the possibility of airborne exposure to inorganic arsenic. (P) Examples of products not requiring labels are semiconductors, lighting diodes and glass). The labels shall bear the following legend:

DANGER

CONTAINS INORGANIC ARSENIC

CANCER HAZARD

HARMFUL IF INHALED OR SWALLOWED

USE ONLY WITH ADEQUATE VENTILATION

OR RESPIRATORY PROTECTION

(q) *Recordkeeping.* (1) *Employee monitoring.* (i) The employer shall establish and maintain an accurate record of all monitoring required by paragraph (e) of this section.

(ii) This record shall include:

(A) The date(s), number, date, location, and results of each sample taken, including a description of the sampling procedure used; and the name of the employee or term representative employee where applicable;

(B) A description of the sampling and analytical methods used and the accuracy of the results;

Employer shall institute a training program for all employees who are subject to exposure to inorganic arsenic above the action level without regard to respirator use, or for whom there is the possibility of skin or eye contact from inorganic arsenic. The employer shall assure that those employees participate in the training program.

The training program shall be completed by October 1, 1978, for employees covered by this provision, at the time of initial assignment for work subsequently covered by this provision, and shall be repeated at least quarterly for employees who have additional use of respirators and at least annually for other covered employees thereafter; and the employer shall assure that each employee is instructed in the following:

(i) The information contained in Appendix A:

The quantity, location, manner of storage, sources of exposure, the specific nature of operations which could result in exposure to inorganic arsenic as well as any necessary protective steps;

The purpose, proper use, and location of respirators;

The purpose and a description of the medical surveillance program as required by paragraph (n) of this section.

The engineering controls and practices associated with the employee's job assignment; and

Review of this standard.

Access to training materials. (i) The employer shall make readily available to all affected employees a copy of this standard and its appendices.

The employer shall provide, upon request, all materials relating to employee information and training program to the Assistant Secretary for the Director.

Signs and labels.—(1) *General.* (i) The employer may use labels or signs in addition to, or in conjunction with, signs and labels required by this paragraph.

The employer shall assure that the legend appears on or near any label required by this paragraph.

Occupational Safety and Health Admin., Labor

§ 1910.1018

graph which contradicts or detracts from the meaning of the required sign or label.

(2) *Signs.* (i) The employer shall post signs demarcating regulated areas bearing the legend:

DANGER

INORGANIC ARSENIC

CANCER HAZARD

AUTHORIZED PERSONNEL ONLY

NO SMOKING OR EATING

RESPIRATOR REQUIRED

(ii) The employer shall assure that signs required by this paragraph are illuminated and cleaned as necessary so that the legend is readily visible.

(3) *Labels.* The employer shall apply precautionary labels to all shipping and storage containers of inorganic arsenic, and to all products containing inorganic arsenic except when the inorganic arsenic in the product is bound in such a manner so as to make unlikely the possibility of airborne exposure to inorganic arsenic. (Possible examples of products not requiring labels are semiconductors, light emitting diodes and glass). The label shall bear the following legend:

DANGER

CONTAINS INORGANIC ARSENIC

CANCER HAZARD

HARMFUL IF INHALED OR SWALLOWED

USE ONLY WITH ADEQUATE VENTILATION

OR RESPIRATORY PROTECTION

(q) *Recordkeeping.*—(1) *Exposure monitoring.* (i) The employer shall establish and maintain an accurate record of all monitoring required by paragraph (e) of this section.

(ii) This record shall include:

(A) The date(s), number, duration, location, and results of each of the samples taken, including a description of the sampling procedure used to determine representative employee exposure where applicable;

(B) A description of the sampling and analytical methods used and evidence of their accuracy;

(C) The type of respiratory protective devices worn, if any;

(D) Name, social security number, and job classification of the employees monitored and of all other employees whose exposure the measurement is intended to represent; and

(E) The environmental variables that could affect the measurement of the employee's exposure.

(iii) The employer shall maintain these monitoring records for at least 40 years or for the duration of employment plus 20 years, whichever is longer.

(2) *Medical surveillance.* (i) The employer shall establish and maintain an accurate record for each employee subject to medical surveillance as required by paragraph (n) of this section.

(ii) This record shall include:

(A) The name, social security number, and description of duties of the employee;

(B) A copy of the physician's written opinions;

(C) Results of any exposure monitoring done for that employee and the representative exposure levels supplied to the physician; and

(D) Any employee medical complaints related to exposure to inorganic arsenic.

(iii) The employer shall in addition keep, or assure that the examining physician keeps, the following medical records:

(A) A copy of the medical examination results including medical and work history required under paragraph (n) of this section;

(B) A description of the laboratory procedures and a copy of any standards or guidelines used to interpret the test results or references to that information;

(C) The initial X-ray;

(D) The X-rays for the most recent 5 years;

(E) Any X-rays with a demonstrated abnormality and all subsequent X-rays;

(F) The initial cytologic examination slide and written description;

(G) The cytologic examination slide and written description for the most recent 5 years; and

(H) Any cytologic examination slides with demonstrated atypia, if such atypia persists for 3 years, and all subsequent slides and written descriptions.

(iv) The employer shall maintain or assure that the physician maintains those medical records for at least 40 years, or for the duration of employment plus 20 years whichever is longer.

(3) *Availability.* (i) The employer shall make available upon request all records required to be maintained by paragraph (q) of this section to the Assistant Secretary and the Director for examination and copying.

(ii) Records required by this paragraph shall be provided upon request to employees, designated representatives, and the Assistant Secretary in accordance with 29 CFR 1910.20 (a) through (e) and (g) through (i).

(4) *Transfer of records.* (i) Whenever the employer ceases to do business, the successor employer shall receive and retain all records required to be maintained by this section.

(ii) Whenever the employer ceases to do business and there is no successor employer to receive and retain the records required to be maintained by this section for the prescribed period, these records shall be transmitted to the Director.

(iii) At the expiration of the retention period for the records required to be maintained by this section, the employer shall notify the Director at least 3 months prior to the disposal of such records and shall transmit those records to the Director if he requests them within that period.

(iv) The employer shall also comply with any additional requirements involving the transfer of records set in 29 CFR 1910.20(h).

(r) *Observation of monitoring.* (1) *Employee observation.* The employer shall provide affected employees or their designated representatives an opportunity to observe any monitoring of employee exposure to inorganic arsenic conducted pursuant to paragraph (e) of this section.

(2) *Observation procedures.* (i) Whenever observation of the monitoring of employee exposure to inorganic arsenic requires entry into an area

where the use of respirators, protective clothing, or equipment is required, the employer shall provide the observer with and assure the use of such respirators, clothing, and such equipment, and shall require the observer to comply with all other applicable safety and health procedures.

(ii) Without interfering with the monitoring, observers shall be entitled to:

(A) Receive an explanation of the measurement procedures;

(B) Observe all steps related to the monitoring of inorganic arsenic performed at the place of exposure; and

(C) Record the results obtained or receive copies of the results when returned by the laboratory.

(s) *Effective date.* This standard shall become effective August 1, 1978.

(t) *Appendices.* The information contained in the appendices to this section is not intended by itself, to create any additional obligations not otherwise imposed by this standard nor detract from any existing obligation.

(u) *Startup dates.* (1) *General.* The startup dates of requirements of this standard shall be the effective date of this standard unless another startup date is provided for either in other paragraphs of this section or in this paragraph.

(2) *Monitoring.* Initial monitoring shall be commenced on August 1, 1978, and shall be completed by September 15, 1978.

(3) *Regulated areas.* Regulated areas required to be established as a result of initial monitoring shall be set up as soon as possible after the results of that monitoring is known and no later than October 1, 1978.

(4) *Compliance program.* The written program required by paragraph (g)(2) as a result of initial monitoring shall be made available for inspection and copying as soon as possible and no later than December 1, 1978.

(5) *Hygiene and lunchroom facilities.* Construction plans for change-rooms, showers, lavatories, and lunchroom facilities shall be completed no later than December 1, 1978, and these facilities shall be constructed and in use no later than July 1, 1979. However, if as part of the compliance plan it is predicted by an independent engi-

neering firm that engineering controls and work practices will reduce exposures below the permissible exposure limit by December 31, 1979, for exposed employees, then such facilities not be completed until 1 year after engineering controls are complete December 31, 1980, whichever is earlier, if such controls have not succeeded in reducing exposure below the permissible exposure limit.

(6) *Summary of startup data.* Set forth elsewhere in this standard.

STARTUP DATES

August 1, 1978—Respirator use over 5 m³.

AS SOON AS POSSIBLE BUT NO LATER THAN September 15, 1978—Completion of monitoring.

October 1, 1978—Complete establishment of regulated areas. Respirator use for employees exposed above 50 µg/m³. Completion of initial training. Notification

December 1, 1978—Respirator use over 50 µg/m³. Completion of initial monitoring. Completion of compliance plan. Use of powered air-purifying respirators. July 1, 1979—Completion of lunch and hygiene facilities.

December 31, 1979—Completion of engineering controls.

All other requirements of the standard as their startup date August 1, 1978.

(Approved by the Office of Management and Budget under control number 0104)

APPENDIX A TO § 1910.1018—INORGANIC ARSENIC SUBSTANCE INFORMATION STATEMENT

I. SUBSTANCE IDENTIFICATION

A. *Substance.* Inorganic Arsenic.

B. *Definition.* Copper acetoarsenite and all inorganic compounds containing arsenic except arsine, measured as arsenic (As).

C. *Permissible Exposure Limit.* 10 grams per cubic meter of air as determined as an average over an 8-hour period. No employee may be exposed to any skin contact with arsenic trichloride or to eye contact likely to cause skin or eye irritation.

D. *Regulated Areas.* Only employees authorized by your employer should enter regulated area.

II. HEALTH HAZARD DATA

A. *Comments.* The health hazard of inorganic arsenic is high.

B. *Ways in which the chemical enters your body.* Exposure to airborne con-

Use of respirators, protecting, or equipment is required, you shall provide the observer to assure the use of such respirators, and such equipment shall require the observer with all other applicable health procedures.

Interfering with the observers shall be entitled

an explanation of the procedures;

all steps related to the of inorganic arsenic per the place of exposure; and the results obtained or of the results when re the laboratory.

effective date. This standard effective August 1, 1978.

The information contained in the appendices to this section is intended by itself, to create obligations not otherwise by this standard nor by existing obligation.

Startup dates—(1) General. The dates of requirements of this standard shall be the effective date of the standard unless another startup date is provided for either in other sections of this section or in this section.

Initial monitoring shall be completed by September 1, 1978.

Regulated areas. Regulated areas shall be established as a result of monitoring shall be set up as soon as possible after the results of monitoring is known and no later than July 1, 1978.

Compliance program. The written program required by paragraph (b) shall be available for inspection as soon as possible and no later than December 1, 1978.

Shower and lunchroom facilities. Construction plans for change rooms, lavatories, and lunchrooms shall be completed no later than July 1, 1978, and these facilities shall be constructed and in use by July 1, 1979. However, the compliance plan it shall be by an independent engi-

neering firm that engineering controls and work practices will reduce exposures below the permissible exposure limit by December 31, 1979, for affected employees, then such facilities need not be completed until 1 year after the engineering controls are completed or December 31, 1980, whichever is earlier, if such controls have not in fact succeeded in reducing exposure to below the permissible exposure limit.

(6) Summary of startup dates set forth elsewhere in this standard.

STARTUP DATES

August 1, 1978—Respirator use over 500 $\mu\text{g}/\text{m}^3$.

AS SOON AS POSSIBLE BUT NO LATER THAN

September 15, 1978—Completion of initial monitoring.

October 1, 1978—Complete establishment of regulated areas. Respirator use for employees exposed above 50 $\mu\text{g}/\text{m}^3$. Completion of initial training. Notification of use.

December 1, 1978—Respirator use over 10 $\mu\text{g}/\text{m}^3$. Completion of initial medical. Completion of compliance plan. Optional use of powered air-purifying respirators.

July 1, 1979—Completion of lunch rooms and hygiene facilities.

December 31, 1979—Completion of engineering controls.

All other requirements of the standard have as their startup date August 1, 1978.

(Approved by the Office of Management and Budget under control number 1218-0104)

APPENDIX A TO § 1910.1018—INORGANIC ARSENIC SUBSTANCE INFORMATION SHEET

I. SUBSTANCE IDENTIFICATION

A. Substance. Inorganic Arsenic.

B. Definition. Copper acetoarsenite, arsenic and all inorganic compounds containing arsenic except arsine, measured as arsenic (As).

C. Permissible Exposure Limit. 10 micrograms per cubic meter of air as determined as an average over an 8-hour period. No employee may be exposed to any skin or eye contact with arsenic trichloride or to skin or eye contact likely to cause skin or eye irritation.

D. Regulated Areas. Only employees authorized by your employer should enter a regulated area.

II. HEALTH HAZARD DATA

A. Comments. The health hazard of inorganic arsenic is high.

B. Ways in which the chemical affects your body. Exposure to airborne concentra-

tions of inorganic arsenic may cause lung cancer, and can be a skin irritant. Inorganic arsenic may also affect your body if swallowed. One compound in particular, arsenic trichloride, is especially dangerous because it can be absorbed readily through the skin. Because inorganic arsenic is a poison, you should wash your hands thoroughly prior to eating or smoking.

III. PROTECTIVE CLOTHING AND EQUIPMENT

A. Respirators. Respirators will be provided by your employer at no cost to you for routine use if your employer is in the process of implementing engineering and work practice controls or where engineering and work practice controls are not feasible or insufficient. You must wear respirators for non-routine activities or in emergency situations where you are likely to be exposed to levels of inorganic arsenic in excess of the permissible exposure limit. Since how well your respirator fits your face is very important, your employer is required to conduct fit tests to make sure the respirator seals properly when you wear it. These tests are simple and rapid and will be explained to you during training sessions.

B. Protective clothing. If you work in a regulated area, your employer is required to provide at no cost to you, and you must wear, appropriate, clean, protective clothing and equipment. The purpose of this equipment is to prevent you from bringing to your home arsenic-contaminated dust and to protect your body from repeated skin contact with inorganic arsenic likely to cause skin irritation. This clothing should include such items as coveralls or similar full-body clothing, gloves, shoes or coverlets, and aprons. Protective equipment should include face shields or vented goggles, where eye irritation may occur.

IV. HYGIENE FACILITIES AND PRACTICES

You must not eat, drink, smoke, chew gum or tobacco, or apply cosmetics in the regulated area, except that drinking water is permitted. If you work in a regulated area your employer is required to provide lunchrooms and other areas for these purposes.

If you work in a regulated area, your employer is required to provide showers, washing facilities, and change rooms. You must wash your face, and hands before eating and must shower at the end of the work shift. Do not take used protective clothing out of change rooms without your employer's permission. Your employer is required to provide for laundering or cleaning of your protective clothing.

V. SIGNS AND LABELS

Your employer is required to post warning signs and labels for your protection. Signs

must be posted in regulated areas. The signs must warn that a cancer hazard is present, that only authorized employees may enter the area, and that no smoking or eating is allowed, and that respirators must be worn.

VI. MEDICAL EXAMINATIONS

If your exposure to arsenic is over the Action Level ($5 \mu\text{g}/\text{m}^3$)—(including all persons working in regulated areas) at least 30 days per year, or you have been exposed to arsenic for more than 10 years over the Action Level, your employer is required to provide you with a medical examination. The examination shall be every 6 months for employees over 45 years old or with more than 10 years exposure over the Action Level and annually for other covered employees. The medical examination must include a medical history; a chest x-ray; skin examination; nasal examination and sputum cytology exam for the early detection of lung cancer. The cytology exams are only included in the initial exam and examinations given after you are either 45 years or older or have 10 or more years employment over the Action Level. The examining physician will provide a written opinion to your employer containing the results of the medical exams. You should also receive a copy of this opinion. The physician must not tell your employer any conditions he detects unrelated to occupational exposure to arsenic but must tell you those conditions.

VII. OBSERVATION OF MONITORING

Your employer is required to monitor your exposure to arsenic and you or your representatives are entitled to observe the monitoring procedure. You are entitled to receive an explanation of the measurement procedure, and to record the results obtained. When the monitoring procedure is taking place in an area where respirators or personal protective clothing and equipment are required to be worn, you must also be provided with and must wear the protective clothing and equipment.

VIII. ACCESS TO RECORDS

You or your representative are entitled to records of your exposure to inorganic arsenic and your medical examination records if you request your employer to provide them.

IX. TRAINING AND NOTIFICATION

Additional information on all of these items plus training as to hazards of exposure to inorganic arsenic and the engineering and work practice controls associated with your job will also be provided by your employer. If you are exposed over the permissible exposure limit, your employer must inform you of that fact and the actions he is taking to reduce your exposures.

APPENDIX B to § 1910.1018—SUBSTANCE TECHNICAL GUIDELINES

ARSENIC, ARSENIC TRIOXIDE, ARSENIC TRICHLORIDE (THREE EXAMPLES)

I. Physical and chemical properties

A. Arsenic (metal).

1. Formula: As.
2. Appearance: Gray metal.
3. Melting point: Sublimes without melting at 613°C .

4. Specific Gravity: ($\text{H}_2\text{O}=1$): 5.73.

5. Solubility in water: Insoluble.

B. Arsenic Trioxide.

1. Formula: As_2O_3 (As406).
2. Appearance: White powder.
3. Melting point: 315°C .
4. Specific Gravity ($\text{H}_2\text{O}=1$): 3.74.
5. Solubility in water: 3.7 grams in 100cc of water at 20°C .

C. Arsenic Trichloride (liquid).

1. Formula: AsCl_3 .
2. Appearance: Colorless or pale yellow liquid.
3. Melting point: -8.5°C .
4. Boiling point: 130.2°C .
5. Specific Gravity ($\text{H}_2\text{O}=1$): 2.16 at 20°C .
6. Vapor Pressure: 10mm Hg at 23.5°C .
7. Solubility in Water: Decomposes in water.

II. Fire, explosion and reactivity data.

A. Fire: Arsenic, arsenic Trioxide and Arsenic Trichloride are nonflammable.

B. Reactivity:

1. Conditions Contributing to instability: Heat.
2. Incompatibility: Hydrogen gas can react with inorganic arsenic to form the highly toxic gas arsine.

III. Monitoring and Measurement Procedures

Samples collected should be full shift (at least 7-hour) samples. Sampling should be done using a personal sampling pump at a flow rate of 2 liters per minute. Samples should be collected on 0.8 micrometer pore size membrane filter (37mm diameter). Volatile arsenicals such as arsenic trichloride can be most easily collected in a midjet bubbler filled with 15 ml. of 0.1 N NaOH.

The method of sampling and analysis should have an accuracy of not less than ± 25 percent (with a confidence limit of 95 percent) for 10 micrograms per cubic meter of air ($10 \mu\text{g}/\text{m}^3$) and ± 35 percent (with a confidence limit of 95 percent) for concentrations of inorganic arsenic between 5 and $10 \mu\text{g}/\text{m}^3$.

APPENDIX C to § 1910.1018—MEDICAL SURVEILLANCE GUIDELINES

I. GENERAL

Medical examinations are to be provided for all employees exposed to levels of inorganic arsenic above the action level ($5 \mu\text{g}/\text{m}^3$) for at least 30 days per year (would include among others, all employees who work in regulated areas). Examinations are also to be provided to all employees who have had 10 years or more exposure to the action level for more than 30 days while working for the present or predecessor employer though they may not be exposed above the level.

An initial medical examination is provided to all such employees by Dec 1, 1978. In addition, an initial medical examination is to be provided to all employees who are first assigned to areas in which worker exposure will probably exceed $5 \mu\text{g}/\text{m}^3$ (after the effective date of this standard) at the time of initial assignment. In addition to its immediate diagnostic usefulness, an initial examination will provide a basis for comparing future test results. The initial examination must include as a minimum the following elements:

(1) A work and medical history, including a smoking history, and presence and absence of respiratory symptoms such as breathlessness, cough, sputum production, and wheezing;

(2) A 14" by 17" posterior-anterior X-ray and an International Labor Union (ILO) (ILO U/C) rating;

(3) A nasal and skin examination;

(4) A Sputum Cytology examination;

(5) Other examinations which the physician believes appropriate because of the employee's exposure to inorganic arsenic and the cause of required respirator use.

Periodic examinations are also to be provided to the employees listed above. Periodic examinations shall be given annually for those covered employees 45 years of age or less with fewer than 10 years of employment in areas where employee exposure exceeds the action level ($5 \mu\text{g}/\text{m}^3$). Periodic examinations need not include sputum cytology and only an updated medical history is required.

Periodic examinations for other covered employees, shall be provided every 6 months. These examinations shall include all tests required in the initial examination except that the medical history need not be updated.

The examination contents are minimum requirements. Additional tests such as chest and oblique X-rays or pulmonary function tests may be useful. For workers exposed to three arsenicals which are associated with lymphatic cancer, copper arsenite, potassium arsenite, or sodium arsenite the examination should also include

C. ARSENIC TRIOXIDE, ARSENIC
TRICHLORIDE (THREE EXAMPLES)

and chemical properties

c (metal).

a. As.

e: Gray metal.

point: Sublimes without melt-

Gravimetric: (H₂O=1):5.73.

in water: Insoluble.

Trioxide.

As₂O₃, (As₄O₆).

ance: White powder.

point: 315°C.

Gravimetric: (H₂O=1):3.74.

in water: 3.7 grams in 100cc

Trichloride (liquid).

C13.

e: Colorless or pale yellow

point: -8.5°C.

point: 130.2°C.

Gravimetric: (H₂O=1):2.16 at 20°C.

Pressure: 10mm Hg at 23.5°C.

in Water: Decomposes in

ion and reactivity data.

enic, arsenic Trioxide and Ar-

side are nonflammable.

ity:

ions Contributing to instability:

ibility: Hydrogen gas can react
and arsenic to form the highly
sine.

ng and Measurement Proce-

collected should be full shift (at
r) samples. Sampling should bepersonal sampling pump at a
2 liters per minute. Samplescollected on 0.8 micrometer pore
brane filter (37mm diameter).

senicals such as arsenic trichlo-

most easily collected in a midget
with 15 ml. of 0.1 N NaOH.

d of sampling and analysis

e an accuracy of not less than

(with a confidence limit of 95

0 micrograms per cubic meter

/m³ and ±35 percent (with a

t of 95 percent) for concen-

an arsenic between 5 and

APPENDIX C to § 1910.1018—MEDICAL
SURVEILLANCE GUIDELINES

I. GENERAL

Medical examinations are to be provided for all employees exposed to levels of inorganic arsenic above the action level (5 µg/m³) for at least 30 days per year (which would include among others, all employees, who work in regulated areas). Examinations are also to be provided to all employees who have had 10 years or more exposure above the action level for more than 30 days per year while working for the present or predecessor employer though they may no longer be exposed above the level.

An initial medical examination is to be provided to all such employees by December 1, 1978. In addition, an initial medical examination is to be provided to all employees who are first assigned to areas in which worker exposure will probably exceed 5 µg/m³ (after the effective date of this standard) at the time of initial assignment. In addition to its immediate diagnostic usefulness, the initial examination will provide a baseline for comparing future test results. The initial examination must include as a minimum the following elements:

(1) A work and medical history, including a smoking history, and presence and degree of respiratory symptoms such as breathlessness, cough, sputum production, and wheezing;

(2) A 14" by 17" posterior-anterior chest X-ray and an International Labor Office UICC/Cincinnati (ILO U/C) rating;

(3) A nasal and skin examination;

(4) A Sputum Cytology examination; and

(5) Other examinations which the physician believes appropriate because of the employee's exposure to inorganic arsenic or because of required respirator use.

Periodic examinations are also to be provided to the employees listed above. The periodic examinations shall be given annually for those covered employees 45 years of age or less with fewer than 10 years employment in areas where employee exposure exceeds the action level (5 µg/m³). Periodic examinations need not include sputum cytology and only an updated medical history is required.

Periodic examinations for other covered employees, shall be provided every six (6) months. These examinations shall include all tests required in the initial examination, except that the medical history need only be updated.

The examination contents are minimum requirements. Additional tests such as lateral and oblique X-rays or pulmonary function tests may be useful. For workers exposed to three arsenicals which are associated with lymphatic cancer, copper acetoarsenite, potassium arsenite, or sodium arsenite the examination should also include pal-

pation of superficial lymph nodes and complete blood count.

II. NONCARCINOGENIC EFFECTS

The OSHA standard is based on minimizing risk of exposed workers dying of lung cancer from exposure to inorganic arsenic. It will also minimize skin cancer from such exposures.

The following three sections quoted from "Occupational Diseases: A Guide to Their Recognition", Revised Edition, June 1977, National Institute for Occupational Safety and Health is included to provide information on the nonneoplastic effects of exposure to inorganic arsenic. Such effects should not occur if the OSHA standards are followed.

A. *Local*—Trivalent arsenic compounds are corrosive to the skin. Brief contact has no effect but prolonged contact results in a local hyperemia and later vesicular or pustular eruption. The moist mucous membranes are most sensitive to the irritant action. Conjunctiva, moist and macerated areas of skin, the eyelids, the angles of the ears, nose, mouth, and respiratory mucosa are also vulnerable to the irritant effects. The wrists are common sites of dermatitis, as are the genitalia if personal hygiene is poor. Perforations of the nasal septum may occur. Arsenic trioxide and pentoxide are capable of producing skin sensitization and contact dermatitis. Arsenic is also capable of producing keratoses, especially of the palms and soles.

B. *Systemic*—The acute toxic effects of arsenic are generally seen following ingestion of inorganic arsenical compounds. This rarely occurs in an industrial setting. Symptoms develop within ¼ to 4 hours following ingestion and are usually characterized by constriction of the throat followed by dysphagia, epigastric pain, vomiting, and watery diarrhea. Blood may appear in vomitus and stools. If the amount ingested is sufficiently high, shock may develop due to severe fluid loss, and death may ensue in 24 hours. If the acute effects are survived, exfoliative dermatitis and peripheral neuritis may develop.

Cases of acute arsenical poisoning due to inhalation are exceedingly rare in industry. When it does occur, respiratory tract symptoms—cough, chest pain, dyspnea—giddiness, headache, and extreme general weakness precede gastrointestinal symptoms. The acute toxic symptoms of trivalent arsenical poisoning are due to severe inflammation of the mucous membranes and greatly increased permeability of the blood capillaries.

Chronic arsenical poisoning due to ingestion is rare and generally confined to patients taking prescribed medications. However, it can be a concomitant of inhaled in-

Attachment C

**Appendix A to 29 CFR 1910.1025
Substance Data Sheet for Occupational Exposure to Lead**

&

**Appendix B to 29 CFR 1910.1025
Employee Standard Summary**

CFR Ch. XVII (7-1-91 Edition)

the effective date. Priority for biological monitoring and medical examinations shall be given to employees whom the employer believes to be at greatest risk from continued exposure.

Initial training and education shall be completed as soon as possible but no later than 180 days from the effective date.

Hygiene and lunchroom facilities shall be in operation as soon as possible but no later than 1 year from the effective year.

(1) Respiratory protection required by paragraph (f) shall be provided as soon as possible but no later than the following schedule:

Employees whose 8-hour TWA exposure exceeds 200 $\mu\text{g}/\text{m}^3$ —on the effective date.

Employees whose 8-hour TWA exposure exceeds the PEL but is less than 200 $\mu\text{g}/\text{m}^3$ —150 days from the effective date.

Powered, air-purifying respirators provided under (f)(2)(ii)—210 days from the effective date.

Quantitative fit testing required under (f)(3)(ii)—one year from effective date. Qualitative fit testing is required in the interim.

(4) Written compliance plans required by paragraph (e)(3) shall be developed and available for inspection and copying as soon as possible but no later than the following schedule:

Employers for whom compliance with the interim level is required within 1 year from the effective date—6 months from the effective date.

Employers in secondary lead smelting, refining and in lead storage battery manufacturing—1 year from the effective date.

Employers in primary smelting and refining—1 year from the effective date or the interim level; 5 years from the effective date for PEL.

Plans for construction of hygiene facilities, if required—6 months from the effective date.

All other industries—1 year from the date on which the court lifts the stay on the implementation of paragraph (e)(1) for the cellular industry.

The permissible exposure limit in paragraph (c) shall become effective 1 year from the effective date.

Occupational Safety and Health Admin., Labor

§ 1910.1025

(Approved by the Office of Management and Budget under control number 1218-0092)

APPENDIX A TO § 1910.1025—SUBSTANCE DATA SHEET FOR OCCUPATIONAL EXPOSURE TO LEAD

I. SUBSTANCE IDENTIFICATION

A. *Substance:* Pure lead (Pb) is a heavy metal at room temperature and pressure and is a basic chemical element. It can combine with various other substances to form numerous lead compounds.

B. *Compounds Covered by the Standard:* The word "lead" when used in this standard means elemental lead, all inorganic lead compounds and a class of organic lead compounds called lead soaps. This standard does not apply to other organic lead compounds.

C. *Uses:* Exposure to lead occurs in at least 120 different occupations, including primary and secondary lead smelting, lead storage battery manufacturing, lead pigment manufacturing and use, solder manufacturing and use, shipbuilding and ship repairing, auto manufacturing, and printing.

D. *Permissible Exposure:* The Permissible Exposure Limit (PEL) set by the standard is 50 micrograms of lead per cubic meter of air (50 $\mu\text{g}/\text{m}^3$), averaged over an 8-hour work-day.

E. *Action Level:* The standard establishes an action level of 30 micrograms per cubic meter of air (30 $\mu\text{g}/\text{m}^3$), time weighted average, based on an 8-hour work-day. The action level initiates several requirements of the standard, such as exposure monitoring, medical surveillance, and training and education.

II. HEALTH HAZARD DATA

A. *Ways in which lead enters your body.* When absorbed into your body in certain doses lead is a toxic substance. The object of the lead standard is to prevent absorption of harmful quantities of lead. The standard is intended to protect you not only from the immediate toxic effects of lead, but also from the serious toxic effects that may not become apparent until years of exposure have passed.

Lead can be absorbed into your body by inhalation (breathing) and ingestion (eating). Lead (except for certain organic lead compounds not covered by the standard, such as tetraethyl lead) is not absorbed through your skin. When lead is scattered in the air as a dust, fume or mist it can be inhaled and absorbed through your lungs and upper respiratory tract. Inhalation of airborne lead is generally the most important source of occupational lead absorption. You can also absorb lead through your digestive system if lead gets into your mouth and is swallowed. If you handle food, cigarettes, chewing tobacco, or make-up which have lead on them or handle them with hands contaminated with lead, this will contribute to ingestion.

A significant portion of the lead that you inhale or ingest gets into your blood stream. Once in your blood stream, lead is circulated throughout your body and stored in various organs and body tissues. Some of this lead is quickly filtered out of your body and excreted, but some remains in the blood and other tissues. As exposure to lead continues, the amount stored in your body will increase if you are absorbing more lead than your body is excreting. Even though you may not be aware of any immediate symptoms of disease, this lead stored in your tissues can be slowly causing irreversible damage, first to individual cells, then to your organs and whole body systems.

B. *Effects of overexposure to lead—(1) Short term (acute) overexposure.* Lead is a potent, systemic poison that serves no known useful function once absorbed by your body. Taken in large enough doses, lead can kill you in a matter of days. A condition affecting the brain called acute encephalopathy may arise which develops quickly to seizures, coma, and death from cardio-respiratory arrest. A short term dose of lead can lead to acute encephalopathy. Short term occupational exposures of this magnitude are highly unusual, but not impossible. Similar forms of encephalopathy may, however, arise from extended, chronic exposure to lower doses of lead. There is no sharp dividing line between rapidly developing acute effects of lead, and chronic effects which take longer to acquire. Lead adversely affects numerous body systems, and causes forms of health impairment and disease which arise after periods of exposure as short as days or as long as several years.

(2) *Long-term (chronic) overexposure.* Chronic overexposure to lead may result in severe damage to your blood-forming, nervous, urinary and reproductive systems. Some common symptoms of chronic overexposure include loss of appetite, metallic taste in the mouth, anxiety, constipation, nausea, pallor, excessive tiredness, weakness, insomnia, headache, nervous irritability, muscle and joint pain or soreness, fine tremors, numbness, dizziness, hyperactivity and colic. In lead colic there may be severe abdominal pain.

Damage to the central nervous system in general and the brain (encephalopathy) in particular is one of the most severe forms of lead poisoning. The most severe, often fatal, form of encephalopathy may be preceded by vomiting, a feeling of dullness progressing to drowsiness and stupor, poor memory, restlessness, irritability, tremor, and convulsions. It may arise suddenly with the onset of seizures, followed by coma, and death.

There is a tendency for muscular weakness to develop at the same time. This weakness may progress to paralysis often observed as a characteristic "wrist drop" or "foot drop" and is a manifestation of a disease to the nervous system called peripheral neuropathy.

Chronic overexposure to lead also results in kidney disease with few, if any, symptoms appearing until extensive and most likely permanent kidney damage has occurred. Routine laboratory tests reveal the presence of this kidney disease only after about two-thirds of kidney function is lost. When overt symptoms of urinary dysfunction arise, it is often too late to correct or prevent worsening conditions, and progression to kidney dialysis or death is possible.

Chronic overexposure to lead impairs the reproductive systems of both men and women. Overexposure to lead may result in decreased sex drive, impotence and sterility in men. Lead can alter the structure of sperm cells raising the risk of birth defects. There is evidence of miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves. Lead exposure also may result in decreased fertility, and abnormal menstrual cycles in women. The course of pregnancy may be adversely affected by exposure to lead since lead crosses the placental barrier and poses risks to developing fetuses. Children born of parents either one of whom were exposed to excess lead levels are more likely to have birth defects, mental retardation, behavioral disorders or die during the first year of childhood.

Overexposure to lead also disrupts the blood-forming system resulting in decreased hemoglobin (the substance in the blood that carries oxygen to the cells) and ultimately anemia. Anemia is characterized by weakness, pallor and fatigability as a result of decreased oxygen carrying capacity in the blood.

(3) *Health protection goals of the standard.* Prevention of adverse health effects for most workers from exposure to lead throughout a working lifetime requires that worker blood lead (PbB) levels be maintained at or below forty micrograms per one hundred grams of whole blood (40 $\mu\text{g}/100\text{g}$). The blood lead levels of workers (both male and female workers) who intend to have children should be maintained below 30 $\mu\text{g}/100\text{g}$ to minimize adverse reproductive health effects to the parents and to the developing fetus.

The measurement of your blood lead level is the most useful indicator of the amount of lead being absorbed by your body. Blood lead levels (PbB) are most often reported in units of milligrams (mg) or micrograms (μg) of lead (1 mg=1000 μg) per 100 grams (100g), 100 milliliters (100 ml) or deciliter (dl) of blood. These three units are essentially

the same. Sometime PbB's are expressed in the form of mg% or $\mu\text{g}\%$. This is a shorthand notation for 100g, 100 ml, or dl.

PbB measurements show the amount of lead circulating in your blood stream, but do not give any information about the amount of lead stored in your various tissues. PbB measurements merely show current absorption of lead, not the effect that lead is having on your body or the effects that past lead exposure may have already caused. Past research into lead-related diseases, however, has focused heavily on associations between PbBs and various diseases. As a result, your PbB is an important indicator of the likelihood that you will gradually acquire a lead-related health impairment or disease.

Once your blood lead level climbs above 40 $\mu\text{g}/100\text{g}$, your risk of disease increases. There is a wide variability of individual response to lead, thus it is difficult to say that a particular PbB in a given person will cause a particular effect. Studies have associated fatal encephalopathy with PbBs as low as 150 $\mu\text{g}/100\text{g}$. Other studies have shown other forms of diseases in some workers with PbBs well below 80 $\mu\text{g}/100\text{g}$. Your PbB is a crucial indicator of the risks to your health, but one other factor is also extremely important. This factor is the length of time you have had elevated PbBs. The longer you have an elevated PbB, the greater the risk that large quantities of lead are being gradually stored in your organs and tissues (body burden). The greater your overall body burden, the greater the chances of substantial permanent damage.

The best way to prevent all forms of lead-related impairments and diseases—both short term and long term—is to maintain your PbB below 40 $\mu\text{g}/100\text{g}$. The provisions of the standard are designed with this end in mind. Your employer has prime responsibility to assure that the provisions of the standard are complied with both by the company and by individual workers. You as a worker, however, also have a responsibility to assist your employer in complying with the standard. You can play a key role in protecting your own health by learning about the lead hazards and their control, learning what the standard requires, following the standard where it governs your own actions, and seeing that your employer complies with provisions governing his actions.

(4) *Reporting signs and symptoms of health problems.* You should immediately notify your employer if you develop signs or symptoms associated with lead poisoning or if you desire medical advice concerning the effects of current or past exposure to lead on your ability to have a healthy child. You should also notify your employer if you have difficulty breathing during a respirator fit test or while wearing a respirator. In

each of these cases your employer must make available to you appropriate medical examinations or consultations. These must be provided at no cost to you and at a reasonable time and place.

The standard contains a procedure whereby you can obtain a second opinion by a physician of your choice if the employer selected the initial physician.

APPENDIX B to § 1910.1025—EMPLOYEE STANDARD SUMMARY

This appendix summarizes key provisions of the standard that you as a worker should become familiar with.

I. PERMISSIBLE EXPOSURE LIMIT (PEL)—PARAGRAPH (C)

The standards sets a permissible exposure limit (PEL) of fifty micrograms of lead per cubic meter of air (50 $\mu\text{g}/\text{m}^3$), averaged over an 8-hour work-day. This is the highest level of lead in air to which you may be permissibly exposed over an 8-hour workday. Since it is an 8-hour average it permits short exposures above the PEL so long as for each 8-hour work day your average exposure does not exceed the PEL.

This standard recognizes that your daily exposure to lead can extend beyond a typical 8-hour workday as the result of overtime or other alterations in your work schedule. To deal with this, the standard contains a formula which reduces your permissible exposure when you are exposed more than 8 hours. For example, if you are exposed to lead for 10 hours a day, the maximum permitted average exposure would be 40 $\mu\text{g}/\text{m}^3$.

II. EXPOSURE MONITORING—PARAGRAPH (D)

If lead is present in the workplace where you work in any quantity, your employer is required to make an initial determination of whether the action level is exceeded for any employee. This initial determination must include instrument monitoring of the air for the presence of lead and must cover the exposure of a representative number of employees who are reasonably believed to have the highest exposure levels. If your employer has conducted appropriate air sampling for lead in the past year he may use these results. If there have been any employee complaints of symptoms which may be attributable to exposure to lead or if there is any other information or observations which would indicate employee exposure to lead, this must also be considered as part of the initial determination. This initial determination must have been completed by March 31, 1979. If this initial determination shows that a reasonable possibility exists that any employee may be exposed, without regard to respirators, over the action level (30 $\mu\text{g}/\text{m}^3$) your employer must set up an air

the same. Sometime PbB's are expressed in the form of mg% or µg%. This is a short-hand notation for 100g, 100 ml, or dl.

PbB measurements show the amount of lead circulating in your blood stream, but do not give any information about the amount of lead stored in your various tissues. PbB measurements merely show current absorption of lead, not the effect that lead is having on your body or the effects that past lead exposure may have already caused. Past research into lead-related diseases, however, has focused heavily on associations between PbBs and various diseases. As a result, your PbB is an important indicator of the likelihood that you will gradually acquire a lead-related health impairment or disease.

Once your blood lead level climbs above 40 µg/100g, your risk of disease increases. There is a wide variability of individual response to lead, thus it is difficult to say that a particular PbB in a given person will cause a particular effect. Studies have associated fatal encephalopathy with PbBs as low as 15 µg/100g. Other studies have shown various forms of diseases in some workers with PbBs well below 80 µg/100g. Your PbB is a crucial indicator of the risks to your health, but one other factor is also extremely important. This factor is the length of time you have had elevated PbBs. The longer you have an elevated PbB, the greater the risk that large quantities of lead are being gradually stored in your organs and tissues (body burden). The greater your overall body burden, the greater the chances of substantial permanent damage.

The best way to prevent all forms of lead-related impairments and diseases—both short term and long term—is to maintain your PbB below 40 µg/100g. The provisions of the standard are designed with this end in mind. Your employer has prime responsibility to assure that the provisions of the standard are complied with both by the company and by individual workers. You as a worker, however, also have a responsibility to assist your employer in complying with the standard. You can play a key role in protecting your own health by learning about the lead hazards and their control, learning what the standard requires, following the standard where it governs your own actions, and seeing that your employer complies with provisions governing his actions.

(4) *Reporting signs and symptoms of health problems.* You should immediately notify your employer if you develop signs or symptoms associated with lead poisoning or if you desire medical advice concerning the effects of current or past exposure to lead on your ability to have a healthy child. You should also notify your employer if you have difficulty breathing during a respiratory test or while wearing a respirator. In

each of these cases your employer must make available to you appropriate medical examinations or consultations. These must be provided at no cost to you and at a reasonable time and place.

The standard contains a procedure whereby you can obtain a second opinion by a physician of your choice if the employer selected the initial physician.

APPENDIX B TO § 1910.1025—EMPLOYEE STANDARD SUMMARY

This appendix summarizes key provisions of the standard that you as a worker should become familiar with.

I. PERMISSIBLE EXPOSURE LIMIT (PEL)—PARAGRAPH (C)

The standard sets a permissible exposure limit (PEL) of fifty micrograms of lead per cubic meter of air (50 µg/m³), averaged over an 8-hour work-day. This is the highest level of lead in air to which you may be permissibly exposed over an 8-hour workday. Since it is an 8-hour average it permits short exposures above the PEL so long as for each 8-hour work day your average exposure does not exceed the PEL.

This standard recognizes that your daily exposure to lead can extend beyond a typical 8-hour workday as the result of overtime or other alterations in your work schedule. To deal with this, the standard contains a formula which reduces your permissible exposure when you are exposed more than 8 hours. For example, if you are exposed to lead for 10 hours a day, the maximum permitted average exposure would be 40 µg/m³.

II. EXPOSURE MONITORING—PARAGRAPH (D)

If lead is present in the workplace where you work in any quantity, your employer is required to make an initial determination of whether the action level is exceeded for any employee. This initial determination must include instrument monitoring of the air for the presence of lead and must cover the exposure of a representative number of employees who are reasonably believed to have the highest exposure levels. If your employer has conducted appropriate air sampling for lead in the past year he may use these results. If there have been any employee complaints of symptoms which may be attributable to exposure to lead or if there is any other information or observations which would indicate employee exposure to lead, this must also be considered as part of the initial determination. This initial determination must have been completed by March 31, 1979. If this initial determination shows that a reasonable possibility exists that any employee may be exposed, without regard to respirators, over the action level (30 µg/m³) your employer must set up an air

monitoring program to determine the exposure level of every employee exposed to lead at your workplace.

In carrying out this air monitoring program, your employer is not required to monitor the exposure of every employee, but he must monitor a representative number of employees and job types. Enough sampling must be done to enable each employee's exposure level to be reasonably represented by at least one full shift (at least 7 hours) air sample. In addition, these air samples must be taken under conditions which represent each employee's regular, daily exposure to lead. All initial exposure monitoring must have been completed by May 30, 1979.

If you are exposed to lead and air sampling is performed, your employer is required to quickly notify you in writing of air monitoring results which represent your exposure. If the results indicate your exposure exceeds the PEL (without regard to your use of respirators), then your employer must also notify you of this in writing, and provide you with a description of the corrective action that will be taken to reduce your exposure.

Your exposure must be rechecked by monitoring every six months if your exposure is over the action level but below the PEL. Air monitoring must be repeated every 3 months if you are exposed over the PEL. Your employer may discontinue monitoring for you if 2 consecutive measurements, taken at least two weeks apart, are below the action level. However, whenever there is a production, process, control, or personnel change at your workplace which may result in new or additional exposure to lead, or whenever there is any other reason to suspect a change which may result in new or additional exposure to lead, your employer must perform additional monitoring.

III. METHODS OF COMPLIANCE—PARAGRAPH (E)

Your employer is required to assure that no employee is exposed to lead in excess of the PEL. The standard establishes a priority of methods to be used to meet the PEL.

IV. RESPIRATORY PROTECTION—PARAGRAPH (F)

Your employer is required to provide and assure your use of respirators when your exposure to lead is not controlled below the PEL by other means. The employer must pay the cost of the respirator. Whenever you request one, your employer is also required to provide you a respirator even if your air exposure level does not exceed the PEL. You might desire a respirator when, for example, you have received medical advice that your lead absorption should be decreased. Or, you may intend to have children in the near future, and want to reduce the level of lead in your body to minimize

adverse reproductive effects. While respirators are the least satisfactory means of controlling your exposure, they are capable of providing significant protection if properly chosen, fitted, worn, cleaned, maintained, and replaced when they stop providing adequate protection.

Your employer is required to select respirators from the seven types listed in Table II of the Respiratory Protection section of the standard. Any respirator chosen must be approved by the Mine Safety and Health Administration (MSHA) or the National Institute for Occupational Safety and Health (NIOSH). This respirator selection table will enable your employer to choose a type of respirator which will give you a proper amount of protection based on your airborne lead exposure. Your employer may select a type of respirator that provides greater protection than that required by the standard; that is, one recommended for a higher concentration of lead than is present in your workplace. For example, a powered air purifying respirator (PAPR) is much more protective than a typical negative pressure respirator, and may also be more comfortable to wear. A PAPR has a filter, cartridge or canister to clean the air, and a power source which continuously blows filtered air into your breathing zone. Your employer might make a PAPR available to you to ease the burden of having to wear a respirator for long periods of time. The standard provides that you can obtain a PAPR upon request.

Your employer must also start a Respiratory Protection Program. This program must include written procedures for the proper selection, use, cleaning, storage, and maintenance of respirators.

Your employer must assure that your respirator facepiece fits properly. Proper fit of a respirator facepiece is critical. Obtaining a proper fit on each employee may require your employer to make available two or three different mask types. In order to assure that your respirator fits properly and that facepiece leakage is minimized, beginning on November 12, 1982, your employer must give you either a qualitative fit test in accordance with Appendix D of the standard or a quantitative fit test if you use a negative pressure respirator. Any respirator which has a filter, cartridge or canister which cleans the work room air before you breathe it and which requires the force of your inhalation to draw air thru the filtering element is a negative pressure respirator. A positive pressure respirator supplies air to you directly. A quantitative fit test uses a sophisticated machine to measure the amount, if any, of test material that leaks into the facepiece of your respirator.

You must also receive from your employer proper training in the use of respirators. Your employer is required to teach you how

to wear a respirator, to know why it is needed, and to understand its limitations.

Until March 1, 1980, your employer must test the effectiveness of your negative pressure respirator initially and at least every six months thereafter with a "qualitative fit test." In this test, the fit of the facepiece is checked by seeing if you can smell a substance placed outside the respirator. If you can, there is appreciable leakage where the facepiece meets your face.

The standard provides that if your respirator uses filter elements, you must be given an opportunity to change the filter elements whenever an increase in breathing resistance is detected. You also must be permitted to periodically leave your work area to wash your face and respirator facepiece whenever necessary to prevent skin irritation. If you ever have difficulty in breathing during a fit test or while using a respirator, your employer must make a medical examination available to you to determine whether you can safely wear a respirator. The result of this examination may be to give you a positive pressure respirator (which reduces breathing resistance) or to provide alternative means of protection.

V. PROTECTIVE WORK CLOTHING AND EQUIPMENT—PARAGRAPH (G)

If you are exposed to lead above the PEL, or if you are exposed to lead compounds such as lead arsenate or lead azide which can cause skin and eye irritation, your employer must provide you with protective work clothing and equipment appropriate for the hazard. If work clothing is provided, it must be provided in a clean and dry condition at least weekly, and daily if your airborne exposure to lead is greater than 200 $\mu\text{g}/\text{m}^3$. Appropriate protective work clothing and equipment can include coveralls or similar full-body work clothing, gloves, hats, shoes or disposable shoe coverlets, and face shields or vented goggles. Your employer is required to provide all such equipment at no cost to you. He is responsible for providing repairs and replacement as necessary, and also is responsible for the cleaning, laundering or disposal of protective clothing and equipment. Contaminated work clothing or equipment must be removed in change rooms and not worn home or you will extend your exposure and expose your family since lead from your clothing can accumulate in your house, car, etc. Contaminated clothing which is to be cleaned, laundered or disposed of must be placed in closed containers in the change room. At no time may lead be removed from protective clothing or equipment by any means which disperses lead into the workroom air.

VI. HOUSEKEEPING—PARAGRAPH (H)

Your employer must establish a housekeeping program sufficient to maintain all surfaces as free as practicable of accumulations of lead dust. Vacuuming is the preferred method of meeting this requirement, and the use of compressed air to clean floors and other surfaces is absolutely prohibited. Dry or wet sweeping, shoveling, or brushing may not be used except where vacuuming or other equally effective methods have been tried and do not work. Vacuums must be used and emptied in a manner which minimizes the reentry of lead into the workplace.

VII. HYGIENE FACILITIES AND PRACTICES—PARAGRAPH (I)

The standard requires that change rooms, showers, and filtered air lunchrooms be constructed and made available to workers exposed to lead above the PEL. When the PEL is exceeded the employer must assure that food and beverage is not present or consumed, tobacco products are not present or used, and cosmetics are not applied, except in these facilities. Change rooms, showers, and lunchrooms, must be used by workers exposed in excess of the PEL. After showering, no clothing or equipment worn during the shift may be worn home, and this includes shoes and underwear. Your own clothing worn during the shift should be carried home and cleaned carefully so that it does not contaminate your home. Lunchrooms may not be entered with protective clothing or equipment unless surface dust has been removed by vacuuming, downdraft booth, or other cleaning method. Finally, workers exposed above the PEL must wash both their hands and faces prior to eating, drinking, smoking or applying cosmetics.

All of the facilities and hygiene practices just discussed are essential to minimize additional sources of lead absorption from inhalation or ingestion of lead that may accumulate on you, your clothes, or your possessions. Strict compliance with these provisions can virtually eliminate several sources of lead exposure which significantly contribute to excessive lead absorption.

VIII. MEDICAL SURVEILLANCE—PARAGRAPH (J)

The medical surveillance program is part of the standard's comprehensive approach to the prevention of lead-related disease. Its purpose is to supplement the main thrust of the standard which is aimed at minimizing airborne concentrations of lead and sources of ingestion. Only medical surveillance can determine if the other provisions of the standard have affectively protected you as an individual. Compliance with the standard's provision will protect most workers from the adverse effects of lead exposure, but may not be satisfactory to protect indi-

a respirator, to know why it is and to understand its limitations. Until March 1, 1980, your employer must test the effectiveness of your negative pressure respirator initially and at least every 6 months thereafter with a "qualitative fit test." In this test, the fit of the facepiece is checked by seeing if you can smell a substance placed outside the respirator. If you detect any appreciable leakage where the facepiece meets your face.

The standard provides that if your respirator uses filter elements, you must be given the opportunity to change the filter element whenever an increase in breathing resistance is detected. You also must be permitted to periodically leave your work area to wash your face and respirator facepiece whenever necessary to prevent skin irritation. If you ever have difficulty in breathing or a fit test or while using a respirator, your employer must make a medical examination available to you to determine whether you can safely wear a respirator. The purpose of this examination may be to give you a positive pressure respirator (which reduces breathing resistance) or to provide alternative means of protection.

V. PROTECTIVE WORK CLOTHING AND EQUIPMENT—PARAGRAPH (G)

If you are exposed to lead above the PEL, you are exposed to lead compounds such as lead arsenate or lead azide which cause skin and eye irritation, your employer must provide you with protective work clothing and equipment appropriate to the hazard. If work clothing is provided, it must be provided in a clean and dry condition at least weekly, and daily if your airborne exposure to lead is greater than 200 µg/m³. Appropriate protective work clothing and equipment can include coveralls or similar full-body work clothing, gloves, hats, shoes or disposable shoe coverlets, and face shields or vented goggles. Your employer is required to provide all such equipment at no cost to you. He is responsible for providing repairs and replacement as necessary, and also is responsible for the cleaning, laundering or disposal of protective clothing and equipment. Contaminated work clothing or equipment must be removed in change rooms and not worn home or you will extend your exposure and expose your family since lead from your clothing can accumulate in your house, car, etc. Contaminated clothing which is to be cleaned, laundered or disposed of must be placed in sealed containers in the change room. At no time may lead be removed from protective clothing or equipment by any means which disperses lead into the workroom air.

VI. HOUSEKEEPING—PARAGRAPH (H)

Your employer must establish a housekeeping program sufficient to maintain all surfaces as free as practicable of accumulations of lead dust. Vacuuming is the preferred method of meeting this requirement, and the use of compressed air to clean floors and other surfaces is absolutely prohibited. Dry or wet sweeping, shoveling, or brushing may not be used except where vacuuming or other equally effective methods have been tried and do not work. Vacuums must be used and emptied in a manner which minimizes the reentry of lead into the workplace.

VII. HYGIENE FACILITIES AND PRACTICES—PARAGRAPH (I)

The standard requires that change rooms, showers, and filtered air lunchrooms be constructed and made available to workers exposed to lead above the PEL. When the PEL is exceeded the employer must assure that food and beverage is not present or consumed, tobacco products are not present or used, and cosmetics are not applied, except in these facilities. Change rooms, showers, and lunchrooms, must be used by workers exposed in excess of the PEL. After showering, no clothing or equipment worn during the shift may be worn home, and this includes shoes and underwear. Your own clothing worn during the shift should be carried home and cleaned carefully so that it does not contaminate your home. Lunchrooms may not be entered with protective clothing or equipment unless surface dust has been removed by vacuuming, downdraft booth, or other cleaning method. Finally, workers exposed above the PEL must wash both their hands and faces prior to eating, drinking, smoking or applying cosmetics.

All of the facilities and hygiene practices just discussed are essential to minimize additional sources of lead absorption from inhalation or ingestion of lead that may accumulate on you, your clothes, or your possessions. Strict compliance with these provisions can virtually eliminate several sources of lead exposure which significantly contribute to excessive lead absorption.

VIII. MEDICAL SURVEILLANCE—PARAGRAPH (J)

The medical surveillance program is part of the standard's comprehensive approach to the prevention of lead-related disease. Its purpose is to supplement the main thrust of the standard which is aimed at minimizing airborne concentrations of lead and sources of ingestion. Only medical surveillance can determine if the other provisions of the standard have effectively protected you as an individual. Compliance with the standard's provision will protect most workers from the adverse effects of lead exposure, but may not be satisfactory to protect indi-

vidual workers (1) who have high body burdens of lead acquired over past years, (2) who have additional uncontrolled sources of non-occupational lead exposure, (3) who exhibit unusual variations in lead absorption rates, or (4) who have specific non-work related medical conditions which could be aggravated by lead exposure (e.g., renal disease, anemia). In addition, control systems may fail, or hygiene and respirator programs may be inadequate. Periodic medical surveillance of individual workers will help detect those failures. Medical surveillance will also be important to protect your reproductive ability—regardless of whether you are a man or woman.

All medical surveillance required by the standard must be performed by or under the supervision of a licensed physician. The employer must provide required medical surveillance without cost to employees and at a reasonable time and place. The standard's medical surveillance program has two parts—periodic biological monitoring and medical examinations.

Your employer's obligation to offer you medical surveillance is triggered by the results of the air monitoring program. Medical surveillance must be made available to all employees who are exposed in excess of the action level for more than 30 days a year. The initial phase of the medical surveillance program, which includes blood lead level tests and medical examinations, must be completed for all covered employees no later than August 28, 1979. Priority within this first round of medical surveillance must be given to employees whom the employer believes to be at greatest risk from continued exposure (for example, those with the longest prior exposure to lead, or those with the highest current exposure). Thereafter, the employer must periodically make medical surveillance—both biological monitoring and medical examinations—available to all covered employees.

Biological monitoring under the standard consists of blood lead level (PbB) and zinc protoporphyrin tests at least every 6 months after the initial PbB test. A zinc protoporphyrin (ZPP) test is a very useful blood test which measures an effect of lead on your body. Thus biological monitoring under the standard is currently limited to PbB testing. If a worker's PbB exceeds 40 µg/100g the monitoring frequency must be increased from every 6 months to at least every 2 months and not reduced until two consecutive PbBs indicate a blood lead level below 40 µg/100g. Each time your PbB is determined to be over 40 µg/100g, your employer must notify you of this in writing within five working days of his receipt of the test results. The employer must also inform you that the standard requires temporary medical removal with economic pro-

section when your PbB exceeds certain criteria. (See Discussion of Medical Removal Protection—Paragraph (k).) During the first year of the standard, this removal criterion is 80 µg/100g. Anytime your PbB exceeds 80 µg/100g your employer must make available to you a prompt follow-up PbB test to ascertain your PbB. If the two tests both exceed 80 µg/100g and you are temporarily removed, then your employer must make successive PbB tests available to you on a monthly basis during the period of your removal.

Medical examinations beyond the initial one must be made available on an annual basis if your blood lead level exceeds 40 µg/100g at any time during the preceding year. The initial examination will provide information to establish a baseline to which subsequent data can be compared. An initial medical examination must also be made available (prior to assignment) for each employee being assigned for the first time to an area where the airborne concentration of lead equals or exceeds the action level. In addition, a medical examination or consultation must be made available as soon as possible if you notify your employer that you are experiencing signs or symptoms commonly associated with lead poisoning or that you have difficulty breathing while wearing a respirator or during a respirator fit test. You must also be provided a medical examination or consultation if you notify your employer that you desire medical advice concerning the effects of current or past exposure to lead on your ability to procreate a healthy child.

Finally, appropriate follow-up medical examinations or consultations may also be provided for employees who have been temporarily removed from exposure under the medical removal protection provisions of the standard. (See Part IX, below.)

The standard specifies the minimum content of pre-assignment and annual medical examinations. The content of other types of medical examinations and consultations is left up to the sound discretion of the examining physician. Pre-assignment and annual medical examinations must include (1) a detailed work history and medical history, (2) a thorough physical examination, and (3) a series of laboratory tests designed to check your blood chemistry and your kidney function. In addition, at any time upon your request, a laboratory evaluation of male fertility will be made (microscopic examination of a sperm sample), or a pregnancy test will be given.

The standard does not require that you participate in any of the medical procedures, tests, etc. which your employer is required to make available to you. Medical surveillance can, however, play a very important role in protecting your health. You are strongly encouraged, therefore, to par-

ticipate in a meaningful fashion. The standard contains a multiple physician review mechanism which would give you a chance to have a physician of your choice directly participate in the medical surveillance program. If you were dissatisfied with an examination by a physician chosen by your employer, you could select a second physician to conduct an independent analysis. The two doctors would attempt to resolve any differences of opinion, and select a third physician to resolve any firm dispute. Generally your employer will choose the physician who conducts medical surveillance under the lead standard—unless you and your employer can agree on the choice of a physician or physicians. Some companies and unions have agreed in advance, for example, to use certain independent medical laboratories or panels of physicians. Any of these arrangements are acceptable so long as required medical surveillance is made available to workers.

The standard requires your employer to provide certain information to a physician to aid in his or her examination of you. This information includes (1) the standard and its appendices, (2) a description of your duties as they relate to lead exposure, (3) your exposure level, (4) a description of personal protective equipment you wear, (5) prior blood lead level results, and (6) prior written medical opinions concerning you that the employer has. After a medical examination or consultation the physician must prepare a written report which must contain (1) the physician's opinion as to whether you have any medical condition which places you at increased risk of material impairment to health from exposure to lead, (2) any recommended special protective measures to be provided to you, (3) any blood lead level determinations, and (4) any recommended limitation on your use of respirators. This last element must include a determination of whether you can wear a powered air purifying respirator (PAPR) if you are found unable to wear a negative pressure respirator.

The medical surveillance program of the lead standard may at some point in time serve to notify certain workers that they have acquired a disease or other adverse medical condition as a result of occupational lead exposure. If this is true, these workers might have legal rights to compensation from public agencies, their employers, firms that supply hazardous products to their employers, or other persons. Some states have laws, including worker compensation laws, that disallow a worker who learns of a job-related health impairment to sue, unless the worker sues within a short period of time after learning of the impairment. (This period of time may be a matter of months or years.) An attorney can be consulted

about these possibilities. It should be stressed that OSHA is in no way trying to either encourage or discourage claims lawsuits. However, since results of the standard's medical surveillance program could significantly affect the legal remedies of a worker who has acquired a job-related disease or impairment, it is proper for OSHA to make you aware of this.

The medical surveillance section of the standard also contains provisions dealing with chelation. Chelation is the use of certain drugs (administered in pill form or injected into the body) to reduce the amount of lead absorbed in body tissues. Experience accumulated by the medical and scientific communities has largely confirmed the effectiveness of this type of therapy for treatment of very severe lead poisoning. On the other hand, it has also been established that there can be a long list of extremely harmful side effects associated with the use of chelating agents. The medical community has balanced the advantages and disadvantages resulting from the use of chelating agents in various circumstances and has established when the use of these agents is acceptable. The standard includes these accepted limitations due to a history of abuse of chelation therapy by some lead companies. The most widely used chelating agents are calcium disodium EDTA, (Ca EDTA), Calcium Disodium Versenate (Versenate), and D-penicillamine (D-penicillamine).

The standard prohibits "prophylactic chelation" of any employee by any person if the employer retains, supervises or controls the employee. "Prophylactic chelation" is the routine use of chelating or similarly acting drugs to prevent elevated blood levels in workers who are occupationally exposed to lead, or the use of these drugs to routinely lower blood lead levels to predesignated concentrations believed to be "safe". It should be emphasized that where an employer takes a worker who has no symptoms of lead poisoning and has chelation carried out by a physician (either inside or outside of a hospital) solely to reduce the worker's blood lead level, that will generally be considered prophylactic chelation. The use of a hospital and a physician does not mean that prophylactic chelation is not being performed. Routine chelation to prevent increased blood lead levels is unacceptable whatever the setting.

	Removal
After Mar. 1, 1980.	70 and ab
After Mar. 1, 1981.	80 and ab
After Mar. 1, 1983.	90 and ab
	six more

meaningful fashion. The standard requires a multiple physician review in which would give you a chance to select a physician of your choice directly in the medical surveillance program. If you were dissatisfied with an examination by a physician chosen by your employer, you could select a second physician for an independent analysis. The standard would attempt to resolve any dispute of opinion, and select a third physician to resolve any firm dispute. Generally, your employer will choose the physician who conducts medical surveillance. The standard is a lead standard—unless you and your employer can agree on the choice of a panel of physicians. Some companies have agreed in advance, for example, to use certain independent medical panels or panels of physicians. Any arrangements are acceptable so long as the medical surveillance is made available to workers.

The standard requires your employer to provide information to a physician for her examination of you. This information includes (1) the standard and indices, (2) a description of your work and the ways they relate to lead exposure, (3) your blood lead level, (4) a description of protective equipment you wear, (5) your previous lead level results, and (6) prior medical opinions concerning you. After a medical examination or consultation the physician must provide a written report which must include the physician's opinion as to whether you have any medical condition that places you at increased risk of material impairment to health from exposure to lead. Any recommended special protective measures to be provided to you, (3) any blood level determinations, and (4) any recommended limitation on your use of respiratory protection. This last element must include a determination of whether you can wear a respirator purifying respirator (PAPR) if found unable to wear a negative pressure respirator.

The medical surveillance program of the standard may at some point in time notify certain workers that they are required a disease or other adverse condition as a result of occupational lead exposure. If this is true, these workers have the legal rights to compensation from the agencies, their employers, firms that supply hazardous products to their employer or other persons. Some states have existing worker compensation laws. Now a worker who learns of a job-related health impairment to sue, unless the worker is within a short period of time of the impairment. (This time may be a matter of months). An attorney can be consulted

about these possibilities. It should be stressed that OSHA is in no way trying to either encourage or discourage claims or lawsuits. However, since results of the standard's medical surveillance program can significantly affect the legal remedies of a worker who has acquired a job-related disease or impairment, it is proper for OSHA to make you aware of this.

The medical surveillance section of the standard also contains provisions dealing with chelation. Chelation is the use of certain drugs (administered in pill form or injected into the body) to reduce the amount of lead absorbed in body tissues. Experience accumulated by the medical and scientific communities has largely confirmed the effectiveness of this type of therapy for the treatment of very severe lead poisoning. On the other hand, it has also been established that there can be a long list of extremely harmful side effects associated with the use of chelating agents. The medical community has balanced the advantages and disadvantages resulting from the use of chelating agents in various circumstances and has established when the use of these agents is acceptable. The standard includes these accepted limitations due to a history of abuse of chelation therapy by some lead companies. The most widely used chelating agents are calcium disodium EDTA, (Ca Na₂ EDTA), Calcium Disodium Versenate (Versenate), and D-penicillamine (penicillamine or Cupramine).

The standard prohibits "prophylactic chelation" of any employee by any person the employer retains, supervises or controls. "Prophylactic chelation" is the routine use of chelating or similarly acting drugs to prevent elevated blood levels in workers who are occupationally exposed to lead, or the use of these drugs to routinely lower blood lead levels to predesignated concentrations believed to be "safe". It should be emphasized that where an employer takes a worker who has no symptoms of lead poisoning and has chelation carried out by a physician (either inside or outside of a hospital) solely to reduce the worker's blood lead level, that will generally be considered prophylactic chelation. The use of a hospital and a physician does not mean that prophylactic chelation is not being performed. Routine chelation to prevent increased or reduce current blood lead levels is unacceptable whatever the setting.

The standard allows the use of "therapeutic" or "diagnostic" chelation if administered under the supervision of a licensed physician in a clinical setting with thorough and appropriate medical monitoring. Therapeutic chelation responds to severe lead poisoning where there are marked symptoms. Diagnostic chelation involved giving a patient a dose of the drug then collecting all urine excreted for some period of time as an aid to the diagnosis of lead poisoning.

In cases where the examining physician determines that chelation is appropriate, you must be notified in writing of this fact before such treatment. This will inform you of a potentially harmful treatment, and allow you to obtain a second opinion.

IX. MEDICAL REMOVAL PROTECTION—PARAGRAPH (K)

Excessive lead absorption subjects you to increased risk of disease. Medical removal protection (MRP) is a means of protecting you when, for whatever reasons, other methods, such as engineering controls, work practices, and respirators, have failed to provide the protection you need. MRP involves the temporary removal of a worker from his or her regular job to a place of significantly lower exposure without any loss of earnings, seniority, or other employment rights or benefits. The purpose of this program is to cease further lead absorption and allow your body to naturally excrete lead which has previously been absorbed. Temporary medical removal can result from an elevated blood lead level, or a medical opinion. Up to 18 months of protection is provided as a result of either form of removal. The vast majority of removed workers, however, will return to their former jobs long before this eighteen month period expires. The standard contains special provisions to deal with the extraordinary but possible case where a longterm worker's blood lead level does not adequately decline during eighteen months of removal.

During the first year of the standard, if your blood lead level is 80 µg/100g or above you must be removed from any exposure where your air lead level without a respirator would be 100 µg/m³ or above. If you are removed from your normal job you may not be returned until your blood lead level declines to at least 60 µg/100g. These criteria for removal and return will change according to the following schedule:

	Removal blood lead (µg/100 g)	Air lead (µg/m ³)	Return blood lead (µg/100 g)
After Mar. 1, 1980	70 and above	50 and above	At or below 50.
After Mar. 1, 1981	60 and above	30 and above	At or below 40.
After Mar. 1, 1983	50 and above averaged over six months.	30 and above	Do.

You may also be removed from exposure even if your blood lead levels are below these criteria if a final medical determination indicates that you temporarily need reduced lead exposure for medical reasons. If the physician who is implementing your employer's medical program makes a final written opinion recommending your removal or other special protective measures, your employer must implement the physician's recommendation. If you are removed in this manner, you may only be returned when the doctor indicates that it is safe for you to do so.

The standard does not give specific instructions dealing with what an employer must do with a removed worker. Your job assignment upon removal is a matter for you, your employer and your union (if any) to work out consistent with existing procedures for job assignments. Each removal must be accomplished in a manner consistent with existing collective bargaining relationships. Your employer is given broad discretion to implement temporary removals so long as no attempt is made to override existing agreements. Similarly, a removed worker is provided no right to veto an employer's choice which satisfies the standard.

In most cases, employers will likely transfer removed employees to other jobs with sufficiently low lead exposure. Alternatively, a worker's hours may be reduced so that the time weighted average exposure is reduced, or he or she may be temporarily laid off if no other alternative is feasible.

In all of these situations, MRP benefits must be provided during the period of removal—i.e., you continue to receive the same earnings, seniority, and other rights and benefits you would have had if you had not been removed. Earnings includes more than just your base wage; it includes overtime, shift differentials, incentives, and other compensation you would have earned if you had not been removed. During the period of removal you must also be provided with appropriate follow-up medical surveillance. If you were removed because your blood lead level was too high, you must be provided with a monthly blood test. If a medical opinion caused your removal, you must be provided medical tests or examinations that the doctor believes to be appropriate. If you do not participate in this follow up medical surveillance, you may lose your eligibility for MRP benefits.

When you are medically eligible to return to your former job, your employer must return you to your "former job status." This means that you are entitled to the position, wages, benefits, etc., you would have had if you had not been removed. If you would still be in your old job if no removal had occurred that is where you go back. If not, you are returned consistent with whatever job assignment discretion your employer would

have had if no removal had occurred. MRP only seeks to maintain your rights, not expand them or diminish them.

If you are removed under MRP and you are also eligible for worker compensation or other compensation for lost wages, your employer's MRP benefits obligation is reduced by the amount that you actually receive from these other sources. This is also true if you obtain other employment during the time you are laid off with MRP benefits.

The standard also covers situations where an employer voluntarily removes a worker from exposure to lead due to the effects of lead on the employee's medical condition, even though the standard does not require removal. In these situations MRP benefits must still be provided as though the standard required removal. Finally, it is important to note that in all cases where removal is required, respirators cannot be used as a substitute. Respirators may be used before removal becomes necessary, but not as an alternative to a transfer, to a low exposure job, or to a lay-off with MRP benefits.

X. EMPLOYEE INFORMATION AND TRAINING— PARAGRAPH (1)

Your employer is required to provide an information and training program for all employees exposed to lead above the action level or who may suffer skin or eye irritation from lead. This program must inform these employees of the specific hazards associated with their work environment, protective measures which can be taken, the danger of lead to their bodies (including their reproductive systems), and their rights under the standard. In addition your employer must make readily available to all employees, including those exposed below the action level, a copy of the standard and its appendices and must distribute to all employees any materials provided to the employer by the Occupational Safety and Health Administration (OSHA).

Your employer is required to complete this training program for all employees by August 28, 1979. After this date, all new employees must be trained prior to initial assignment to areas where there is a possibility of exposure over the action level.

This training program must also be provided at least annually thereafter.

XI. SIGNS—PARAGRAPH (M)

The standard requires that the following warning sign be posted in work areas where the exposure to lead exceeds the PEL:

Occupational Safety and Health A

WARNING

LEAD WORK AREA

NO SMOKING OR EATING

XII. RECORDKEEPING—PARAGRAPH (N)

Your employer is required to keep records of exposure monitoring for airborne lead. These records must include the name and job classification of employees measured, details of the sampling and analytical techniques, the results of this sampling, the type of respiratory protection being worn by the person sampled. Your employer is also required to keep all records of biological monitoring and medical examination results. These must include the names of employees, the physician's written opinion, and a copy of the results of the examination. All of the above kinds of records must be kept for 40 years, or for at least 20 years after your termination of employment whichever is longer.

Recordkeeping is also required if you temporarily removed from your job under the medical removal protection program. This record must include your name, social security number, the date of your removal and return, how the removal was accomplished, and whether or not the reason for the removal was an elevated blood lead level. Your employer is required to keep each medical removal record on file for as long as the duration of an employee's employment.

The standard requires that if you request to see or copy environmental monitoring blood lead level monitoring, or medical removal records, they must be made available to you or to a representative that you authorize. Your union also has access to the records. Medical records other than Pbl must also be provided upon request to you or to your physician or to any other person whom you may specifically designate. Your union does not have access to your personal medical records unless you authorize this access.

XIII. OBSERVATIONS OF MONITORING— PARAGRAPH (O)

When air monitoring for lead is performed at your workplace as required by this standard, your employer must allow you or someone you designate to act as an observer of the monitoring. Observers are entitled to an explanation of the measurement procedure, and to record the results obtained. Since results will not normally be available at the time of the monitoring, observers are entitled to record or receive the results of the monitoring when returned to the laboratory. Your employer is required to provide the observer with any personal protective devices required to be worn in

and if no removal had occurred. MRP seeks to maintain your rights, not to diminish them. If you are removed under MRP and you are so eligible for worker compensation or compensation for lost wages, your employer's MRP benefits obligation is reduced to the amount that you actually receive from these other sources. This is also true if you obtain other employment during the time you are laid off with MRP benefits. The standard also covers situations where an employer voluntarily removes a worker from exposure to lead due to the effects of the employee's medical condition. Although the standard does not require removal in these situations MRP benefits still be provided as though the standard required removal. Finally, it is important to note that in all cases where removal is required, respirators cannot be used as a substitute. Respirators may be used before removal becomes necessary, but not as an alternative to a transfer to a low exposure area or a lay-off with MRP benefits.

**EMPLOYEE INFORMATION AND TRAINING—
PARAGRAPH (I)**

Your employer is required to provide an information and training program for all employees exposed to lead above the action level or who may suffer skin or eye irritation from lead. This program must inform employees of the specific hazards associated with their work environment, proper measures which can be taken, the effects of lead to their bodies (including reproductive systems), and their rights under the standard. In addition your employer must make readily available to all employees, including those exposed below the action level, a copy of the standard and appendices and must distribute to all employees many materials provided to the employees by the Occupational Safety and Health Administration (OSHA).

Your employer is required to complete an information and training program for all employees by March 28, 1979. After this date, all new employees must be trained prior to initial assignment to areas where there is a possibility of exposure over the action level. The training program must also be provided at least annually thereafter.

XI. SIGNS—PARAGRAPH (M)

The standard requires that the following sign be posted in work areas where exposure to lead exceeds the PEL:

**WARNING
LEAD WORK AREA**

NO SMOKING OR EATING

XII. RECORDKEEPING—PARAGRAPH (N)

Your employer is required to keep all records of exposure monitoring for airborne lead. These records must include the name and job classification of employees measured, details of the sampling and analytic techniques, the results of this sampling, and the type of respiratory protection being worn by the person sampled. Your employer is also required to keep all records of biological monitoring and medical examination results. These must include the names of the employees, the physician's written opinion, and a copy of the results of the examination. All of the above kinds of records must be kept for 40 years, or for at least 20 years after your termination of employment, whichever is longer.

Recordkeeping is also required if you are temporarily removed from your job under the medical removal protection program. This record must include your name and social security number, the date of your removal and return, how the removal was or is being accomplished, and whether or not the reason for the removal was an elevated blood lead level. Your employer is required to keep each medical removal record only for as long as the duration of an employee's employment.

The standard requires that if you request to see or copy environmental monitoring, blood lead level monitoring, or medical removal records, they must be made available to you or to a representative that you authorize. Your union also has access to these records. Medical records other than PbB's must also be provided upon request to you, to your physician or to any other person whom you may specifically designate. Your union does not have access to your personal medical records unless you authorize their access.

**XIII. OBSERVATIONS OF MONITORING—
PARAGRAPH (O)**

When air monitoring for lead is performed at your workplace as required by this standard, your employer must allow you or someone you designate to act as an observer of the monitoring. Observers are entitled to an explanation of the measurement procedure, and to record the results obtained. Since results will not normally be available at the time of the monitoring, observers are entitled to record or receive the results of the monitoring when returned by the laboratory. Your employer is required to provide the observer with any personal protective devices required to be worn by

employees working in the area that is being monitored. The employer must require the observer to wear all such equipment and to comply with all other applicable safety and health procedures.

XIV. EFFECTIVE DATE—PARAGRAPH (P)

The standard's effective date is March 1, 1979, and employer obligations under the standard begin to come into effect as of that date.

XV. FOR ADDITIONAL INFORMATION

A. Copies of the Standard and explanatory materials can be obtained free of charge by calling or writing the OSHA Office of Publications, Room S-1212, United States Department of Labor, Washington, D.C. 20210; Telephone (202) 523-6138. The following publications are available:

1. The standard and summary of the statement of reasons (preamble), *FEDERAL REGISTER*, Volume 43, pp. 52952-53014, November 14, 1978.
2. The full statement of reasons (preamble), *FEDERAL REGISTER*, vol. 43, pp. 54354-54509, November 21, 1978.
3. Partial Administrative Stay and Corrections to the standard, (44 FR 5446-5448) January 26, 1979.
4. Notice of the Partial Judicial Stay (44 FR 14554-14555) March 13, 1979.
5. Corrections to the preamble, *FEDERAL REGISTER*, vol. 44, pp. 20680-20681, April 6, 1979.
6. Additional correction to the preamble concerning the construction industry, *FEDERAL REGISTER*, vol. 44, p. 50338, August 28, 1979.
7. Appendices to the standard (Appendices A, B, C), *FEDERAL REGISTER*, Vol. 44, pp. 60980-60995, October 23, 1979.
8. Corrections to appendices, *FEDERAL REGISTER*, Vol. 44, 68828, November 30, 1979.
9. Revision to the standard and additional appendices (Appendices D and E), *FEDERAL REGISTER*, Vol. 47, pp. 51117-51119, November 12, 1982.

B. Additional information about the standard, its enforcement, and your employer's compliance can be obtained from the nearest OSHA Area Office listed in your telephone directory under United States Government/Department of Labor.

**APPENDIX C TO § 1910.1025—MEDICAL
SURVEILLANCE GUIDELINES**

INTRODUCTION

The primary purpose of the Occupational Safety and Health Act of 1970 is to assure, so far as possible, safe and healthful working conditions for every working man and woman. The occupational health standard

for inorganic lead¹ was promulgated to protect workers exposed to inorganic lead including metallic lead, all inorganic lead compounds and organic lead soaps.

Under this final standard in effect as of March 1, 1979, occupational exposure to inorganic lead is to be limited to 50 $\mu\text{g}/\text{m}^3$ (micrograms per cubic meter) based on an 8 hour time-weighted average (TWA). This level of exposure eventually must be achieved through a combination of engineering, work practice and other administrative controls. Periods of time ranging from 1 to 10 years are provided for different industries to implement these controls. The schedule which is based on individual industry considerations is given in Table 1. Until these controls are in place, respirators must be used to meet the 50 $\mu\text{g}/\text{m}^3$ exposure limit.

The standard also provides for a program of biological monitoring and medical surveillance for all employees exposed to levels of inorganic lead above the action level of 30 $\mu\text{g}/\text{m}^3$ (TWA) for more than 30 days per year.

The purpose of this document is to outline the medical surveillance provisions of the standard for inorganic lead, and to provide further information to the physician regarding the examination and evaluation of workers exposed to inorganic lead.

Section 1 provides a detailed description of the monitoring procedure including the required frequency of blood testing for exposed workers, provisions for medical removal protection (MRP), the recommended right of the employee to a second medical opinion, and notification and recordkeeping requirements of the employer. A discussion of the requirements for respirator use and respirator monitoring and OSHA's position on prophylactic chelation therapy are also included in this section.

Section 2 discusses the toxic effects and clinical manifestations of lead poisoning and effects of lead intoxication on enzymatic pathways in heme synthesis. The adverse effects on both male and female reproductive capacity and on the fetus are also discussed.

Section 3 outlines the recommended medical evaluation of the worker exposed to inorganic lead including details of the medical history, physical examination, and recommended laboratory tests, which are based on the toxic effects of lead as discussed in Section 2.

Section 4 provides detailed information concerning the laboratory tests available for the monitoring of exposed workers. Included also is a discussion of the relative value of each test and the limitations and precautions which are necessary in the interpretation of the laboratory results.

was between 40 $\mu\text{g}/100$ g whole blood a the level requiring employee medical removal to be discussed below. For employees who are removed from exposure to lead due to an elevated blood lead, a new blood lead level must be measured monthly. A zinc protoporphyrin (ZPP) measurement is strongly recommended on each occasion that a blood lead level measurement is made.

An annual medical examination and consultation performed under the guidelines discussed in Section 3 is to be made available to each employee for whom a blood test conducted at any time during the preceding 12 months indicated a blood lead level at or above 40 $\mu\text{g}/100$ g. Also, an examination is to be given to all employees prior to their assignment to an area in which airborne lead concentrations reach or exceed the action level. In addition, a medical examination must be provided as soon as possible after notification by an employee that the employee has developed signs or symptoms commonly associated with lead intoxication, that the employee desires medical advice regarding lead exposure and the al

TABLE 1

Permissible airborne lead levels by industry ($\mu\text{g}/\text{m}^3$) ¹	Effective date					
	Mar. 1, 1979	Mar. 1, 1980	Mar. 1, 1981	Mar. 1, 1982	Mar. 1, 1984	Mar. 1, 1989 (final)
1. Primary lead production	200	200	200	100	100	50
2. Secondary lead production	200	200	200	100	50	50
3. Lead-acid battery manufacturing	200	200	100	100	50	50
4. Nonferrous foundries	200	100	100	100	50	50
5. Lead pigment manufacturing	200	200	200	100	50	50
6. All other industries	200	50	50	50	50	50

¹ Airborne levels to be achieved without reliance on respirator protection through a combination of engineering, work practice and other administrative controls. While these controls are being implemented respirators must be used to meet the 50 $\mu\text{g}/\text{m}^3$ exposure limit.

1. MEDICAL SURVEILLANCE AND MONITORING REQUIREMENTS FOR WORKERS EXPOSED TO INORGANIC LEAD

Under the occupational health standard for inorganic lead, a program of biological monitoring and medical surveillance is to be made available to all employees exposed to lead above the action level of 30 $\mu\text{g}/\text{m}^3$ TWA for more than 30 days each year. This program consists of periodic blood sampling

and medical evaluation to be performed on a schedule which is defined by previous laboratory results, worker complaints or concerns, and the clinical assessment of the examining physician.

Under this program, the blood lead level of all employees who are exposed to lead above the action level of 30 $\mu\text{g}/\text{m}^3$ is to be determined at least every six months. The frequency is increased to every two months for employees whose last blood lead level

¹The term inorganic lead used throughout the medical surveillance appendices is

meant to be synonymous with the definition of lead set forth in the standard.

provides a detailed description of the monitoring procedure including the frequency of blood testing for ex-posed workers, provisions for medical removal protection (MRP), the recommended removal of an employee to a second medical examination, notification and recordkeeping requirements of the employer. A discussion of the requirements for respirator use and biological monitoring and OSHA's position on chelation therapy are also included in this section.

2. discusses the toxic effects and manifestations of lead poisoning and lead intoxication on enzymatic heme synthesis. The adverse effects on both male and female reproductive health and on the fetus are also discussed.

3. outlines the recommended medical examination of the worker exposed to lead, including details of the medical physical examination, and recommended laboratory tests, which are based on the effects of lead as discussed in Section 2.

4. provides detailed information on the laboratory tests available for monitoring of exposed workers. Including a discussion of the relative value of the tests and the limitations and precautions necessary in the interpretation of laboratory results.

Effective date

1.	Mar. 1, 1981	Mar. 1, 1982	Mar. 1, 1984	Mar. 1, 1989 (final)
200	200	100	100	50
200	200	100	50	50
200	100	100	50	50
200	100	100	50	50
200	200	100	50	50
200	50	50	50	50

When a combination of engineering, work practice controls and respirators must be used to meet the 50 $\mu\text{g}/\text{m}^3$ standard.

The evaluation to be performed on the worker which is defined by previous laboratory results, worker complaints or concerns, or the clinical assessment of the physician.

In this program, the blood lead level of employees who are exposed to lead at an action level of 30 $\mu\text{g}/\text{m}^3$ is to be measured at least every six months. The frequency is increased to every two months for employees whose last blood lead level was above the action level.

The term "blood lead level" is synonymous with the definition of blood lead in the standard.

was between 40 $\mu\text{g}/100$ g whole blood and the level requiring employee medical removal to be discussed below. For employees who are removed from exposure to lead due to an elevated blood lead, a new blood lead level must be measured monthly. A zinc protoporphyrin (ZPP) measurement is strongly recommended on each occasion that a blood lead level measurement is made.

An annual medical examination and consultation performed under the guidelines discussed in Section 3 is to be made available to each employee for whom a blood test conducted at any time during the preceding 12 months indicated a blood lead level at or above 40 $\mu\text{g}/100$ g. Also, an examination is to be given to all employees prior to their assignment to an area in which airborne lead concentrations reach or exceed the action level. In addition, a medical examination must be provided as soon as possible after notification by an employee that the employee has developed signs or symptoms commonly associated with lead intoxication, that the employee desires medical advice regarding lead exposure and the abil-

ity to procreate a healthy child, or that the employee has demonstrated difficulty in breathing during a respirator fitting test or during respirator use. An examination is also to be made available to each employee removed from exposure to lead due to a risk of sustaining material impairment to health, or otherwise limited or specially protected pursuant to medical recommendations.

Results of biological monitoring or the recommendations of an examining physician may necessitate removal of an employee from further lead exposure pursuant to the standard's medical removal protection (MRP) program. The object of the MRP program is to provide temporary medical removal to workers either with substantially elevated blood lead levels or otherwise at risk of sustaining material health impairment from continued substantial exposure to lead. The following guidelines which are summarized in Table 2 were created under the standard for the temporary removal of an exposed employee and his or her subsequent return to work in an exposure area.

TABLE 2

	Effective date				
	Mar. 1, 1979	Mar. 1, 1980	Mar. 1, 1981	Mar. 1, 1982	Mar. 1, 1983 (Final)
A. Blood lead level requiring employee medical removal. (Level must be confirmed with second follow-up blood lead level within two weeks of first report).	$\geq 80 \mu\text{g}/100 \text{ g}$	$\geq 70 \mu\text{g}/100 \text{ g}$	$\geq 80 \mu\text{g}/100 \text{ g}$	$\geq 80 \mu\text{g}/100 \text{ g}$	$\geq 80 \mu\text{g}/100 \text{ g}$ or average of last three blood samples or all blood samples over previous 6 months (whichever is over a longer time period) is $50 \mu\text{g}/100 \text{ g}$ or greater unless last blood sample is $40 \mu\text{g}/100 \text{ g}$ or less.
B. Frequency which employees exposed to action level of lead ($30 \mu\text{g}/\text{m}^3 \text{ TWA}$) must have blood lead level checked (ZPP is also strongly recommended in each occasion that a blood lead is obtained):	Every 6 months Every 2 months	Every 6 months Every 2 months	Every 6 months Every 2 months	Every 6 months Every 2 months	Every 6 months Every 2 months
1. Last blood lead level less than $40 \mu\text{g}/100 \text{ g}$	Every 1 month	Every 1 month	Every 1 month	Every 1 month	Every 1 month
2. Last blood lead level between $40 \mu\text{g}/100 \text{ g}$ and level requiring medical removal (see A above).	Every 1 month	Every 1 month	Every 1 month	Every 1 month	Every 1 month
3. Employees removed from exposure to lead because of an elevated blood lead level.	100 $\mu\text{g}/\text{m}^3 \text{ 8 hr TWA}$	50 $\mu\text{g}/\text{m}^3 \text{ 8 hr TWA}$	30 $\mu\text{g}/\text{m}^3 \text{ 8 hr TWA}$	30 $\mu\text{g}/\text{m}^3 \text{ 8 hr TWA}$	30 $\mu\text{g}/\text{m}^3 \text{ 8 hr TWA}$
C. Permissible airborne exposure limit for workers removed from work due to an elevated blood lead level (without regard to respirator protection).	$< 80 \mu\text{g}/100 \text{ g}$	$< 50 \mu\text{g}/100 \text{ g}$	$< 40 \mu\text{g}/100 \text{ g}$	$< 40 \mu\text{g}/100 \text{ g}$	$< 40 \mu\text{g}/100 \text{ g}$
D. Blood lead level confirmed with a second blood analysis, at which employee may return to work. Permissible exposure without regard to respirator protection is listed by industry in Table 1.					

NOTE: When medical opinion indicates that an employee is at risk of material impairment from exposure to lead, the physician can remove an employee from exposure exceeding the action level (or less) or recommend special protective measures as deemed appropriate and necessary. Medical monitoring during the medical removal period can be more stringent than noted in this table above if the physician so specifies. Return to work or removal of limitations and special protections is permitted when the physician indicates that the worker is no longer at risk of material impairment.

Under the standard's ultimate work removal criteria, a worker is to be removed from any work having any eight hour exposure to lead of $30 \mu\text{g}/\text{m}^3$ or more if ever either of the following circumstances apply: (1) a blood lead level of $80 \mu\text{g}/100 \text{ g}$ or greater is obtained and confirmed second follow-up blood lead level performed within two weeks after the employee receives the results of the first blood sample test, or (2) the average of the previous blood lead determinations or the average of all blood lead determinations conducted during the previous six months, which encompasses the longest time period, equals or exceeds $50 \mu\text{g}/100 \text{ g}$, unless the last sample indicates a blood lead level below $40 \mu\text{g}/100 \text{ g}$ in which case the employee need not be removed. Medical removal to continue until two consecutive blood levels are $40 \mu\text{g}/100 \text{ g}$ or less.

During the first two years that the ultimate removal criteria are being phased, the return criteria have been set to a level that a worker's blood lead level has substantially declined during the period of removal. From March 1, 1979 to March 1, 1980 blood lead level requiring employee removal is $80 \mu\text{g}/100 \text{ g}$. Workers four have a confirmed blood lead at this level greater need only be removed from having a daily 8 hour TWA exposure to at or above $100 \mu\text{g}/\text{m}^3$. Workers so removed are to be returned to work when their blood lead levels are at or below $60 \mu\text{g}/100 \text{ g}$ whole blood. From March 1, 1980 to March 1, 1981, the blood lead level requiring removal is $70 \mu\text{g}/100 \text{ g}$. During period workers need only be removed jobs having a daily 8 hour TWA exposure lead at or above $50 \mu\text{g}/\text{m}^3$ and are to be returned to work when a level of $50 \mu\text{g}/100 \text{ g}$ is achieved. Beginning March 1, 1981, return depends on a worker's blood lead level declining to $40 \mu\text{g}/100 \text{ g}$ of whole blood.

As part of the standard, the employer required to notify in writing each employee whose blood lead level exceeds $40 \mu\text{g}/100 \text{ g}$. In addition each such employee is to be informed that the standard requires medical removal with MRP benefits, discussed below, when an employee's blood lead exceeds the above defined limits.

In addition to the above blood lead criteria, temporary worker removal also take place as a result of medical examinations and recommendations. Written medical opinions must be prepared for each examination pursuant to the standard. If the examining physician includes a medical finding, determination or opinion that the employee has a medical condition which places the employee at increased risk of material health impairment from exposure to lead, then the employee must be removed from exposure to lead at or above the action level. Alternatively, if the examining physician

Under the standard's ultimate worker removal criteria, a worker is to be removed from any work having any eight hour TWA exposure to lead of $30 \mu\text{g}/\text{m}^3$ or more when ever either of the following circumstances apply: (1) a blood lead level of $60 \mu\text{g}/100 \text{ g}$ or greater is obtained and confirmed by a second follow-up blood lead level performed within two weeks after the employer receives the results of the first blood sampling test, or (2) the average of the previous three blood lead determinations or the average of all blood lead determinations conducted during the previous six months, whichever encompasses the longest time period, equals or exceeds $50 \mu\text{g}/100 \text{ g}$, unless the last blood sample indicates a blood lead level at or below $40 \mu\text{g}/100 \text{ g}$ in which case the employee need not be removed. Medical removal is to continue until two consecutive blood lead levels are $40 \mu\text{g}/100 \text{ g}$ or less.

During the first two years that the ultimate removal criteria are being phased in, the return criteria have been set to assure that a worker's blood lead level has substantially declined during the period of removal. From March 1, 1979 to March 1, 1980, the blood lead level requiring employee medical removal is $80 \mu\text{g}/100 \text{ g}$. Workers found to have a confirmed blood lead at this level or greater need only be removed from work having a daily 8 hour TWA exposure to lead at or above $100 \mu\text{g}/\text{m}^3$. Workers so removed are to be returned to work when their blood lead levels are at or below $60 \mu\text{g}/100 \text{ g}$ of whole blood. From March 1, 1980 to March 1, 1981, the blood lead level requiring medical removal is $70 \mu\text{g}/100 \text{ g}$. During this period workers need only be removed from jobs having a daily 8 hour TWA exposure to lead at or above $50 \mu\text{g}/\text{m}^3$ and are to be returned to work when a level of $50 \mu\text{g}/100 \text{ g}$ is achieved. Beginning March 1, 1981, return depends on a worker's blood lead level declining to $40 \mu\text{g}/100 \text{ g}$ of whole blood.

As part of the standard, the employer is required to notify in writing each employee whose blood lead level exceeds $40 \mu\text{g}/100 \text{ g}$. In addition each such employee is to be informed that the standard requires medical removal with MRP benefits, discussed below, when an employee's blood lead level exceeds the above defined limits.

In addition to the above blood lead level criteria, temporary worker removal may also take place as a result of medical determinations and recommendations. Written medical opinions must be prepared after each examination pursuant to the standard. If the examining physician includes a medical finding, determination or opinion that the employee has a medical condition which places the employee at increased risk of material health impairment from exposure to lead, then the employee must be removed from exposure to lead at or above the action level. Alternatively, if the examining physi-

cian recommends special protective measures for an employee (e.g., use of a powered air purifying respirator) or recommends limitations on an employee's exposure to lead, then the employer must implement these recommendations. Recommendations may be more stringent than the specific provisions of the standard. The examining physician, therefore, is given broad flexibility to tailor special protective procedures to the needs of individual employees. This flexibility extends to the evaluation and management of pregnant workers and male and female workers who are planning to raise children. Based on the history, physical examination, and laboratory studies, the physician might recommend special protective measures or medical removal for an employee who is pregnant or who is planning to conceive a child when, in the physician's judgment, continued exposure to lead at the current job would pose a significant risk. The return of the employee to his or her former job status, or the removal of special protections or limitations, depends upon the examining physician determining that the employee is no longer at increased risk of material impairment or that special measures are no longer needed.

During the period of any form of special protection or removal, the employer must maintain the worker's earnings, seniority, and other employment rights and benefits (as though the worker had not been removed) for a period of up to 18 months. This economic protection will maximize meaningful worker participation in the medical surveillance program, and is appropriate as part of the employer's overall obligation to provide a safe and healthful workplace. The provisions of MRP benefits during the employee's removal period may, however, be conditioned upon participation in medical surveillance.

On rare occasions, an employee's blood lead level may not acceptably decline within 18 months of removal. This situation will arise only in unusual circumstances, thus the standard relies on an individual medical examination to determine how to protect such an employee. This medical determination is to be based on both laboratory values, including lead levels, zinc protoporphyrin levels, blood counts, and other tests felt to be warranted, as well as the physician's judgment that any symptoms or findings on physical examination are a result of lead toxicity. The medical determination may be that the employee is incapable of ever safely returning to his or her former job status. The medical determination may provide additional removal time past 18 months for some employees or specify special protective measures to be implemented.

The lead standard provides for a multiple physician review in cases where the employ-

Wishes a second opinion concerning potential lead poisoning or toxicity. If an employee wishes a second opinion, he or she can make an appointment with a physician of his or her choice. This second physician will review the findings, recommendations or determinations of the first physician and conduct any examinations, consultations or tests deemed necessary in an attempt to make a final medical determination. If the first and second physicians do not agree in their assessment they must try to resolve their differences. If they cannot reach an agreement then they must designate a third physician to resolve the dispute.

The employer must provide examining and consulting physicians with the following specific information: a copy of the lead regulations and all appendices, a description of the employee's duties as related to exposure, the exposure level to lead and any other toxic substances (if applicable), a description of personal protective equipment used, blood lead levels, and all prior written medical opinions regarding the employee in the employer's possession or control. The employer must also obtain from the physician and provide the employee with a written medical opinion containing blood lead levels, the physician's opinion as to whether the employee is at risk of material impairment to health, any recommended protective measures for the employee if further exposure is permitted, as well as any recommended limitations upon an employee's use of respirators.

Employers must instruct each physician not to reveal to the employer in writing or in any other way his or her findings, laboratory results, or diagnoses which are felt to be unrelated to occupational lead exposure. They must also instruct each physician to advise the employee of any occupationally or non-occupationally related medical condition requiring further treatment or evaluation.

The standard provides for the use of respirators where engineering and other primary controls have not been fully implemented. However, the use of respirator protection shall not be used in lieu of temporary medical removal due to elevated blood lead levels or findings that an employee is at risk of material health impairment. This is based on the numerous inadequacies of respirators including skin rash where the facepiece makes contact with the skin, unacceptable stress to breathing in some workers with underlying cardiopulmonary impairment, difficulty in providing adequate fit, the tendency for respirators to create additional hazards by interfering with vision, hearing, and mobility, and the difficulties of assuring the maximum effectiveness of a complicated work practice program involving respirators. Respirators do, however, serve a useful function where engineering and work prac-

tice controls are inadequate by providing supplementary, interim, or short-term protection, provided they are properly selected for the environment in which the employee will be working, properly fitted to the employee, maintained and cleaned periodically, and worn by the employee when required.

In its final standard on occupational exposure to inorganic lead, OSHA has prohibited prophylactic chelation. Diagnostic and therapeutic chelation are permitted only under the supervision of a licensed physician with appropriate medical monitoring in an acceptable clinical setting. The decision to initiate chelation therapy must be made on an individual basis and take into account the severity of symptoms felt to be a result of lead toxicity along with blood lead levels, ZPP levels, and other laboratory tests as appropriate. EDTA and penicillamine which are the primary chelating agents used in the therapy of occupational lead poisoning have significant potential side effects and their use must be justified on the basis of expected benefits to the worker. Unless frank and severe symptoms are present, therapeutic chelation is not recommended given the opportunity to remove a worker from exposure and allow the body to naturally excrete accumulated lead. As a diagnostic aid, the chelation mobilization test using CA-EDTA has limited applicability. According to some investigators, the test can differentiate between lead-induced and other nephropathies. The test may also provide an estimation of the mobile fraction of the total body lead burden.

Employers are required to assure that accurate records are maintained on exposure monitoring, medical surveillance, and medical removal for each employee. Exposure monitoring and medical surveillance records must be kept for 40 years or the duration of employment plus 20 years, whichever is longer, while medical removal records must be maintained for the duration of employment. All records required under the standard must be made available upon request to the Assistant Secretary of Labor for Occupational Safety and Health and the Director of the National Institute for Occupational Safety and Health. Employers must also make environmental and biological monitoring and medical removal records available to affected employees and to former employees or their authorized employee representatives. Employees or their specifically designated representatives have access to their entire medical surveillance records.

In addition, the standard requires that the employer inform all workers exposed to lead at or above the action level of the provisions of the standard and all its appendices, the purpose and description of medical surveillance and provisions for medical re-

moval protection if temporary removal is required. An understanding of the potential health effects of lead exposure by all posed employees along with full understanding of their rights under the standard is essential for an effective monitoring program.

II. ADVERSE HEALTH EFFECTS OF INORGANIC LEAD

Although the toxicity of lead has been known for 2,000 years, the knowledge of complex relationship between lead exposure and human response is still being refined. Significant research into the toxic properties of lead continues throughout the world and it should be anticipated that our understanding of thresholds of effects and margins of safety will be improved in future years. The provisions of the lead standard are founded on two prime medical judgments: first, the prevention of adverse health effects from exposure to lead throughout a working lifetime requires worker blood lead levels be maintained below 40 $\mu\text{g}/100\text{ g}$ and second, the blood lead levels of workers, male or female, intend to parent in the near future should be maintained below 30 $\mu\text{g}/100\text{ g}$ to minimize adverse reproductive health effects to the parents and developing fetus. The adverse effects of lead on reproduction being actively researched and OSHA encourages the physician to remain abreast of recent developments in the area to advise pregnant workers or workers intending to conceive children.

The spectrum of health effects caused by lead exposure can be subdivided into five developmental stages: normal, physiological changes of uncertain significance, preclinical changes, overt symptoms (morbidity), and mortality. Within the process there are no sharp distinctions rather a continuum of effects. Boundaries between categories overlap due to the variation of individual responses and differences in the working population. OSHA development of the lead standard focuses on pathophysiological changes as well as stages of disease.

1. *Heme Synthesis Inhibition.* The demonstrated effect of lead involves its ability to inhibit at least two enzymes of the heme synthesis pathway at very low blood lead levels. Inhibition of delta aminolevulinic acid dehydrase (ALA-D) which catalyzes the conversion of delta-aminolevulinic acid (ALA) to protoporphyrin is observed at blood lead levels below 20 $\mu\text{g}/100\text{ g}$ blood. At a blood lead level of 40 $\mu\text{g}/100\text{ g}$ blood, more than 20% of the population have 70% inhibition of ALA-D. There is an exponential increase in ALA excretion in blood lead levels greater than 40 $\mu\text{g}/100\text{ g}$.

Occupational Safety and Health Admin., Labor

§ 1910.1025

removal protection if temporary removal is required. An understanding of the potential health effects of lead exposure by all exposed employees along with full understanding of their rights under the lead standard is essential for an effective monitoring program.

II. ADVERSE HEALTH EFFECTS OF INORGANIC LEAD

Although the toxicity of lead has been known for 2,000 years, the knowledge of the complex relationship between lead exposure and human response is still being refined. Significant research into the toxic properties of lead continues throughout the world, and it should be anticipated that our understanding of thresholds of effects and margins of safety will be improved in future years. The provisions of the lead standard are founded on two prime medical judgments: first, the prevention of adverse health effects from exposure to lead throughout a working lifetime requires that worker blood lead levels be maintained at or below 40 $\mu\text{g}/100\text{ g}$ and second, the blood lead levels of workers, male or female, who intend to parent in the near future should be maintained below 30 $\mu\text{g}/100\text{ g}$ to minimize adverse reproductive health effects to the parents and developing fetus. The adverse effects of lead on reproduction are being actively researched and OSHA encourages the physician to remain abreast of recent developments in the area to best advise pregnant workers or workers planning to conceive children.

The spectrum of health effects caused by lead exposure can be subdivided into five developmental stages: normal, physiological changes of uncertain significance, pathological changes, overt symptoms (morbidity), and mortality. Within this process there are no sharp distinctions, but rather a continuum of effects. Boundaries between categories overlap due to the wide variation of individual responses and exposures in the working population. OSHA's development of the lead standard focused on pathophysiological changes as well as later stages of disease.

1. *Heme Synthesis Inhibition.* The earliest demonstrated effect of lead involves its ability to inhibit at least two enzymes of the heme synthesis pathway at very low blood levels. Inhibition of delta aminolevulinic acid dehydrase (ALA-D) which catalyzes the conversion of delta-aminolevulinic acid (ALA) to protoporphyrin is observed at a blood lead level below 20 $\mu\text{g}/100\text{ g}$ whole blood. At a blood lead level of 40 $\mu\text{g}/100\text{ g}$, more than 20% of the population would have 70% inhibition of ALA-D. There is an exponential increase in ALA excretion at blood lead levels greater than 40 $\mu\text{g}/100\text{ g}$.

Another enzyme, ferrochelatase, is also inhibited at low blood lead levels. Inhibition of ferrochelatase leads to increased free erythrocyte protoporphyrin (FEP) in the blood which can then bind to zinc to yield zinc protoporphyrin. At a blood lead level of 50 $\mu\text{g}/100\text{ g}$ or greater, nearly 100% of the population will have an increase in FEP. There is also an exponential relationship between blood lead levels greater than 40 $\mu\text{g}/100\text{ g}$ and the associated ZPP level, which has led to the development of the ZPP screening test for lead exposure.

While the significance of these effects is subject to debate, it is OSHA's position that these enzyme disturbances are early stages of a disease process which may eventually result in the clinical symptoms of lead poisoning. Whether or not the effects do progress to the later stages of clinical disease, disruption of these enzyme processes over a working lifetime is considered to be a material impairment of health.

One of the eventual results of lead-induced inhibition of enzymes in the heme synthesis pathway is anemia which can be asymptomatic if mild but associated with a wide array of symptoms including dizziness, fatigue, and tachycardia when more severe. Studies have indicated that lead levels as low as 50 $\mu\text{g}/100\text{ g}$ can be associated with a definite decreased hemoglobin, although most cases of lead-induced anemia, as well as shortened red-cell survival times, occur at lead levels exceeding 80 $\mu\text{g}/100\text{ g}$. Inhibited hemoglobin synthesis is more common in chronic cases whereas shortened erythrocyte life span is more common in acute cases.

In lead-induced anemias, there is usually a reticulocytosis along with the presence of basophilic stippling, and ringed sideroblasts, although none of the above are pathognomonic for lead-induced anemia.

2. *Neurological Effects.* Inorganic lead has been found to have toxic effects on both the central and peripheral nervous systems. The earliest stages of lead-induced central nervous system effects first manifest themselves in the form of behavioral disturbances and central nervous system symptoms including irritability, restlessness, insomnia and other sleep disturbances, fatigue, vertigo, headache, poor memory, tremor, depression, and apathy. With more severe exposure, symptoms can progress to drowsiness, stupor, hallucinations, delirium, convulsions, and coma.

The most severe and acute form of lead poisoning which usually follows ingestion or inhalation of large amounts of lead is acute encephalopathy which may arise precipitously with the onset of intractable seizures, coma, cardiorespiratory arrest, and death within 48 hours.

al Safety and Health

is as low as 25 $\mu\text{g}/100\text{ g}$. body of literature conc health effects of lead in feels that the blood lead should be maintained bei a population mean of 1 lead levels in the fetu wise should not exceed 3

lead's ability to pass th barrier and also because adverse effects of lead nction in both the mal l as the risk of genetic d h the ovum and sperm. a 30 $\mu\text{g}/100\text{ g}$ maximum l lead level in both male rish to bear children. ic effects. Debate and re the effects of lead o Hypertension has frequ occupationally exposed igh it is difficult to s due to lead's adverse r or if some other mecha ular and electrocardiog been detected but hav acterized. Lead is thou l function and interfer adrenal axis, but again it been well defined.

MEDICAL EVALUATION

important principle in ev any occupational dise olsoning is a high inv e part of the examin used in Section 2, let is organ systems and p signs and symptoms, n specific and subtle in arly stages of disease. for lead toxicity is p arly clues to diagnosi oked.

Initial step in the n recognizing that a w n result in exposure t frequently be able to d and lead containing will not volunteer this specifically asked. In rker may not know ad but the suspicion e part of the physic dustry or occupation al occupational expo pounds occur in at le cluding lead smeltir lead storage batteri lead pigments and p ents, solder manu l ship repair, auto m ion, and painting. ibility for lead expo us can then be c information from th

emia necessitating dialysis. There is associated hypertension and anemia with or without gout.

Kidney disease is difficult to detect. Analysis is normal in early lead nephropathy and the blood urea nitrogen, and creatinine increase only when two-kidney function is lost. Measurement of creatinine clearance can often earlier disease as can other methods of measurement of glomerular filtration rate. Normal Ca-EDTA mobilization can be used to differentiate between lead and other nephropathies, but this procedure is not widely accepted. A Fanconi syndrome with aminoaciduria, and hyperphosphaturia, a severe injury to the proximal tubules is occasionally seen in chil-

Reproductive effects. Exposure to lead has serious effects on reproductive function in both males and females. In males exposed to lead there can be a decreased sexual drive, impotence, decreased production of healthy sperm, and sterility. Abnormal sperm (teratospermia), decreased number of sperm (hypospermia), and sperm with decreased motility (asthenospermia) can all occur. Teratospermia has been reported at mean blood lead levels of 53 $\mu\text{g}/100\text{ g}$ and hypospermia and asthenospermia at 50 $\mu\text{g}/100\text{ g}$. Furthermore, there appears to be a dose-response relationship for sterility in lead exposed workers.

Women exposed to lead may experience menstrual disturbances including dysmenorrhea, menorrhagia and amenorrhea. Following exposure to lead, women have a decreased frequency of sterility, premature spontaneous miscarriages, and still-

births can be affected by lead and genetic damage in the egg or sperm before conception and result in failure of miscarriage, stillbirth, or birth

of mothers with lead poisoning show higher mortality during the first year after birth, lower birth weights, growth, and nervous system disor-

ders pass through the placental barrier. Lead levels in the mother's blood are comparable to concentrations of lead in the umbilical cord at birth. Transplacental transfer becomes detectable at 12-14 weeks and increases until birth.

There is little direct data on damage to the fetus from exposure to lead but it is assumed that the fetus and newborn are at least as susceptible to neurotoxic damage as young children. Blood lead levels of 50-60 $\mu\text{g}/100\text{ g}$ in children can cause significant neurobehavioral impairment. There is evidence of hyperactivity

at blood levels as low as 25 $\mu\text{g}/100\text{ g}$. Given the overall body of literature concerning the adverse health effects of lead in children, OSHA feels that the blood lead level in children should be maintained below 30 $\mu\text{g}/100\text{ g}$ with a population mean of 15 $\mu\text{g}/100\text{ g}$. Blood lead levels in the fetus and newborn likewise should not exceed 30 $\mu\text{g}/100\text{ g}$.

Because of lead's ability to pass through the placental barrier and also because of the demonstrated adverse effects of lead on reproductive function in both the male and female as well as the risk of genetic damage of lead on both the ovum and sperm, OSHA recommends a 30 $\mu\text{g}/100\text{ g}$ maximum permissible blood lead level in both males and females who wish to bear children.

6. Other toxic effects. Debate and research continue on the effects of lead on the human body. Hypertension has frequently been noted in occupationally exposed individuals although it is difficult to assess whether this is due to lead's adverse effects on the kidney or if some other mechanism is involved. Vascular and electrocardiographic changes have been detected but have not been well characterized. Lead is thought to impair thyroid function and interfere with the pituitary-adrenal axis, but again these effects have not been well defined.

III. MEDICAL EVALUATION

The most important principle in evaluating a worker for any occupational disease including lead poisoning is a high index of suspicion on the part of the examining physician. As discussed in Section 2, lead can affect numerous organ systems and produce a wide array of signs and symptoms, most of which are non-specific and subtle in nature at least in the early stages of disease. Unless serious concern for lead toxicity is present, many of the early clues to diagnosis may easily be overlooked.

The crucial initial step in the medical evaluation is recognizing that a worker's employment can result in exposure to lead. The worker will frequently be able to define exposures to lead and lead containing materials but often will not volunteer this information unless specifically asked. In other situations the worker may not know of any exposures to lead but the suspicion might be raised on the part of the physician because of the industry or occupation of the worker. Potential occupational exposure to lead and its compounds occur in at least 120 occupations, including lead smelting, the manufacture of lead storage batteries, the manufacture of lead pigments and products containing pigments, solder manufacture, shipbuilding and ship repair, auto manufacturing, construction, and painting.

Once the possibility for lead exposure is raised, the focus can then be directed toward eliciting information from the medi-

cal history, physical exam, and finally from laboratory data to evaluate the worker for potential lead toxicity.

A complete and detailed work history is important in the initial evaluation. A listing of all previous employment with information on work processes, exposure to fumes or dust, known exposures to lead or other toxic substances, respiratory protection used, and previous medical surveillance should all be included in the worker's record. Where exposure to lead is suspected, information concerning on-the-job personal hygiene, smoking or eating habits in work areas, laundry procedures, and use of any protective clothing or respiratory protection equipment should be noted. A complete work history is essential in the medical evaluation of a worker with suspected lead toxicity, especially when long term effects such as neurotoxicity and nephrotoxicity are considered.

The medical history is also of fundamental importance and should include a listing of all past and current medical conditions, current medications including proprietary drug intake, previous surgeries and hospitalizations, allergies, smoking history, alcohol consumption, and also non-occupational lead exposures such as hobbies (hunting, riflery). Also known childhood exposures should be elicited. Any previous history of hematological, neurological, gastrointestinal, renal, psychological, gynecological, genetic, or reproductive problems should be specifically noted.

A careful and complete review of systems must be performed to assess both recognized complaints and subtle or slowly acquired symptoms which the worker might not appreciate as being significant. The review of symptoms should include the following:

General—weight loss, fatigue, decreased appetite.

Head, Eyes, Ears, Nose, Throat (HEENT)—headaches, visual disturbances or decreased visual acuity, hearing deficits or tinnitus, pigmentation of the oral mucosa, or metallic taste in mouth.

Cardio-pulmonary—shortness of breath, cough, chest pains, palpitations, or orthopnea.

Gastrointestinal—nausea, vomiting, heartburn, abdominal pain, constipation or diarrhea.

Neurologic—irritability, insomnia, weakness (fatigue), dizziness, loss of memory, confusion, hallucinations, incoordination, ataxia, decreased strength in hands or feet, disturbances in gait, difficulty in climbing stairs, or seizures.

Hematologic—pallor, easy fatigability, abnormal blood loss, melena.

Reproductive (male and female and spouse where relevant)—history of infertil-

ity, impotence, loss of libido, abnormal menstrual periods, history of miscarriages, stillbirths, or children with birth defects.

Musculo-skeletal—muscle and joint pains.

The physical examination should emphasize the neurological, gastrointestinal, and cardiovascular systems. The worker's weight and blood pressure should be recorded and the oral mucosa checked for pigmentation characteristic of a possible Burtonian or lead line on the gingiva. It should be noted, however, that the lead line may not be present even in severe lead poisoning if good oral hygiene is practiced.

The presence of pallor on skin examination may indicate an anemia, which if severe might also be associated with a tachycardia. If an anemia is suspected, an active search for blood loss should be undertaken including potential blood loss through the gastrointestinal tract.

A complete neurological examination should include an adequate mental status evaluation including a search for behavioral and psychological disturbances, memory testing, evaluation for irritability, insomnia, hallucinations, and mental clouding. Gait and coordination should be examined along with close observation for tremor. A detailed evaluation of peripheral nerve function including careful sensory and motor function testing is warranted. Strength testing particularly of extensor muscle groups of all extremities is of fundamental importance.

Cranial nerve evaluation should also be included in the routine examination.

The abdominal examination should include auscultation for bowel sounds and abdominal bruits and palpation for organomegaly, masses, and diffuse abdominal tenderness.

Cardiovascular examination should evaluate possible early signs of congestive heart failure. Pulmonary status should be addressed particularly if respirator protection is contemplated.

As part of the medical evaluation, the lead standard requires the following laboratory studies:

1. Blood lead level
2. Hemoglobin and hematocrit determinations, red cell indices, and examination of the peripheral blood smear to evaluate red blood cell morphology
3. Blood urea nitrogen
4. Serum creatinine
5. Routine urinalysis with microscopic examination.
6. A zinc protoporphyrin level

In addition to the above, the physician is authorized to order any further laboratory or other tests which he or she deems necessary in accordance with sound medical practice. The evaluation must also include pregnancy testing or laboratory evaluation of male fertility if requested by the employee.

Additional tests which are probably not warranted on a routine basis but may be appropriate when blood lead and ZPP levels are equivocal include delta aminolevulinic acid and coproporphyrin concentrations in the urine, and dark-field illumination for detection of basophilic stippling in red blood cells.

If an anemia is detected further studies including a careful examination of the peripheral smear, reticulocyte count, stool for occult blood, serum iron, total iron binding capacity, bilirubin, and, if appropriate, vitamin B12 and folate may be of value in attempting to identify the cause of the anemia.

If a peripheral neuropathy is suspected, nerve conduction studies are warranted both for diagnosis and as a basis to monitor any therapy.

If renal disease is questioned, a 24 hour urine collection for creatinine clearance, protein, and electrolytes may be indicated. Elevated uric acid levels may result from lead-induced renal disease and a serum uric acid level might be performed.

An electrocardiogram and chest x-ray may be obtained as deemed appropriate.

Sophisticated and highly specialized testing should not be done routinely and where indicated should be under the direction of a specialist.

IV. LABORATORY EVALUATION

The blood lead level at present remains the single most important test to monitor lead exposure and is the test used in the medical surveillance program under the lead standard to guide employee medical removal. The ZPP has several advantages over the blood lead level. Because of its relatively recent development and the lack of extensive data concerning its interpretation, the ZPP currently remains an ancillary test.

This section will discuss the blood lead level and ZPP in detail and will outline their relative advantages and disadvantages. Other blood tests currently available to evaluate lead exposure will also be reviewed.

The blood lead level is a good index of current or recent lead absorption when there is no anemia present and when the worker has not taken any chelating agents. However, blood lead levels along with urinary lead levels do not necessarily indicate the total body burden of lead and are not adequate measures of past exposure. One reason for this is that lead has a high affinity for bone and up to 90% of the body's total lead is deposited there. A very important component of the total lead body burden is lead in soft tissue (liver, kidney, and brain). This fraction of the lead body burden, the biologically active lead, is not entirely reflected by blood lead levels since it is a function of the dynamics of lead ab-

sorption, distribution, deposition in, and excretion. Following discontinua exposure to lead, the excess body burden is only slowly mobilized from bone and relatively stable body stores and excreted. Consequently, a high blood lead level only represent recent heavy exposure without a significant total body burden and likewise a low blood lead level does not exclude an elevated total body burden.

Also due to its correlation with exposures, the blood lead level may vary considerably over short time intervals.

To minimize laboratory error and to ensure results due to contamination, specimens must be carefully collected through thorough cleaning of the skin with appropriate methods using lead-free blockers and analyzed by a reliable laboratory. Under the standard, samples must be analyzed in laboratories which are approved by the Center for Disease Control (CDC) which have received satisfactory proficiency testing by the CDC in the previous year. Analysis is to be made by atomic absorption spectrophotometry, anodic stripping voltammetry, or a method which meets the accuracy requirements set forth by the standard.

The determination of lead in urine is generally considered a less reliable method than analysis of whole blood, primarily due to individual variability in urinary excretion capacity as well as the technical difficulty of obtaining accurate hour urine collections. In addition, with renal insufficiency, whether lead or some other cause, may have decreased lead clearance and consequently urine lead levels may underestimate true lead burden. Therefore, urine levels should not be used as a routine method.

The zinc protoporphyrin test, unlike blood lead determination, measures the reverse metabolic effect of lead and as a better indicator of lead toxicity than the level of blood lead itself. The level reflects lead absorption over the previous 4 months, and therefore is a better indicator of lead body burden. The test requires more time than the blood lead test, and significantly elevated levels; thus to normal after discontinuing lead exposure is also slower. Furthermore, the ZPP test is simpler, faster, and less expensive in form and no contamination is required. Many investigators believe it is the most reliable means of monitoring chronic lead exposure.

Zinc protoporphyrin results from the inhibition of the enzyme ferrochelatase, which catalyzes the insertion of an iron atom into the protoporphyrin molecule, then becomes heme. If iron is not available, then zinc, having

Additional tests which are probably not done on a routine basis but may be appropriate when blood lead and ZPP levels are equivocal include delta aminolevulinic acid and coproporphyrin concentrations in urine, and dark-field illumination for detection of basophilic stippling in red blood cells.

If anemia is detected further studies including a careful examination of the peripheral smear, reticulocyte count, stool for occult blood, serum iron, total iron binding capacity, bilirubin, and, if appropriate, vitamin B₁₂ and folate may be of value in attempting to identify the cause of the anemia.

If peripheral neuropathy is suspected, nerve conduction studies are warranted for diagnosis and as a basis to monitor therapy.

If renal disease is questioned, a 24 hour urine collection for creatinine clearance, urea, and electrolytes may be indicated. Elevated uric acid levels may result from lead-induced renal disease and a serum uric acid level might be performed.

Electrocardiogram and chest x-ray may be indicated as deemed appropriate.

Highly sophisticated and highly specialized tests should not be done routinely and where indicated should be under the direction of a specialist.

IV. LABORATORY EVALUATION

The blood lead level at present remains the single most important test to monitor lead exposure and is the test used in the federal surveillance program under the lead standard to guide employee medical removal. The ZPP has several advantages over the blood lead level. Because of its relatively rapid development and the lack of extensive data concerning its interpretation, the ZPP currently remains an ancillary test.

This section will discuss the blood lead level and ZPP in detail and will outline their relative advantages and disadvantages. The blood tests currently available to estimate lead exposure will also be reviewed. The blood lead level is a good index of current or recent lead absorption when there is no anemia present and when the blood has not taken any chelating agents. However, blood lead levels along with urinary lead levels do not necessarily indicate the total body burden of lead and are not accurate measures of past exposure. One reason for this is that lead has a high affinity for bone and up to 90% of the body's total lead is deposited there. A very important component of the total lead body burden is lead in soft tissue (liver, kidney, brain). This fraction of the lead body burden, the biologically active lead, is not reflected by blood lead levels since the function of the dynamics of lead ab-

sorption, distribution, deposition in bone and excretion. Following discontinuation of exposure to lead, the excess body burden is only slowly mobilized from bone and other relatively stable body stores and excreted. Consequently, a high blood lead level may only represent recent heavy exposure to lead without a significant total body excess and likewise a low blood lead level does not exclude an elevated total body burden of lead.

Also due to its correlation with recent exposures, the blood lead level may vary considerably over short time intervals.

To minimize laboratory error and erroneous results due to contamination, blood specimens must be carefully collected after thorough cleaning of the skin with appropriate methods using lead-free blood containers and analyzed by a reliable laboratory. Under the standard, samples must be analyzed in laboratories which are approved by the Center for Disease Control (CDC) or which have received satisfactory grades in proficiency testing by the CDC in the previous year. Analysis is to be made using atomic absorption spectrophotometry, anodic stripping voltammetry or any method which meets the accuracy requirements set forth by the standard.

The determination of lead in urine is generally considered a less reliable monitoring technique than analysis of whole blood primarily due to individual variability in urinary excretion capacity as well as the technical difficulty of obtaining accurate 24 hour urine collections. In addition, workers with renal insufficiency, whether due to lead or some other cause, may have decreased lead clearance and consequently urine lead levels may underestimate the true lead burden. Therefore, urine lead levels should not be used as a routine test.

The zinc protoporphyrin test, unlike the blood lead determination, measures an adverse metabolic effect of lead and as such is a better indicator of lead toxicity than the level of blood lead itself. The level of ZPP reflects lead absorption over the preceding 3 to 4 months, and therefore is a better indicator of lead body burden. The ZPP requires more time than the blood lead to read significantly elevated levels; the return to normal after discontinuing lead exposure is also slower. Furthermore, the ZPP test is simpler, faster, and less expensive to perform and no contamination is possible. Many investigators believe it is the most reliable means of monitoring chronic lead absorption.

Zinc protoporphyrin results from the inhibition of the enzyme ferrochelatase which catalyzes the insertion of an iron molecule into the protoporphyrin molecule, which then becomes heme. If iron is not inserted into the molecule then zinc, having a great-

er affinity for protoporphyrin, takes the place of the iron, forming ZPP.

An elevation in the level of circulating ZPP may occur at blood lead levels as low as 20-30 µg/100 g in some workers. Once the blood lead level has reached 40 µg/100 g there is more marked rise in the ZPP value from its normal range of less than 100 µg/100 ml. Increases in blood lead levels beyond 40 µg/100 g are associated with exponential increases in ZPP.

Whereas blood lead levels fluctuate over short time spans, ZPP levels remain relatively stable. ZPP is measured directly in red blood cells and is present for the cell's entire 120 day life-span. Therefore, the ZPP level in blood reflects the average ZPP production over the previous 3-4 months and consequently the average lead exposure during that time interval.

It is recommended that a hematocrit be determined whenever a confirmed ZPP of 50 µg/100 ml whole blood is obtained to rule out a significant underlying anemia. If the ZPP is in excess of 100 µg/100 ml and not associated with abnormal elevations in blood lead levels, the laboratory should be checked to be sure that blood leads were determined using atomic absorption spectrophotometry anodic stripping voltammetry, or any method which meets the accuracy requirements set forth by the standard by a CDC approved laboratory which is experienced in lead level determinations. Repeat periodic blood lead studies should be obtained in all individuals with elevated ZPP levels to be certain that an associated elevated blood lead level has not been missed due to transient fluctuations in blood leads.

ZPP has a characteristic fluorescence spectrum with a peak at 594 nm which is detectable with a hematofluorimeter. The hematofluorimeter is accurate and portable and can provide on-site, instantaneous results for workers who can be frequently tested via a finger prick.

However, careful attention must be given to calibration and quality control procedures. Limited data on blood lead-ZPP correlations and the ZPP levels which are associated with the adverse health effects discussed in Section 2 are the major limitations of the test. Also it is difficult to correlate ZPP levels with environmental exposure and there is some variation of response with age and sex. Nevertheless, the ZPP promises to be an important diagnostic test for the early detection of lead toxicity and its value will increase as more data is collected regarding its relationship to other manifestations of lead poisoning.

Levels of delta-aminolevulinic acid (ALA) in the urine are also used as a measure of lead exposure. Increasing concentrations of ALA are believed to result from the inhibition of the enzyme delta-aminolevulinic acid

dehydroase (ALA-D). Although the test is relatively easy to perform, inexpensive, and rapid, the disadvantages include variability in results, the necessity to collect a complete 24 hour urine sample which has a specific gravity greater than 1.010, and also the fact that ALA decomposes in the presence of light.

The pattern of porphyrin excretion in the urine can also be helpful in identifying lead intoxication. With lead poisoning, the urine concentrations of coproporphyrins I and II, porphobilinogen and uroporphyrin I rise. The most important increase, however, is that of coproporphyrin III; levels may exceed 5,000 µg/l in the urine in lead poisoned individuals, but its correlation with blood lead levels and ZPP are not as good as those of ALA. Increases in urinary porphyrins are not diagnostic of lead toxicity and may be seen in porphyria, some liver diseases, and in patients with high reticulocyte counts.

Summary. The Occupational Safety and Health Administration's standard for inorganic lead places significant emphasis on the medical surveillance of all workers exposed to levels of inorganic lead above the action level of 30 µg/m³ TWA. The physician has a fundamental role in this surveillance program, and in the operation of the medical removal protection program.

Even with adequate worker education on the adverse health effects of lead and appropriate training in work practices, personal hygiene and other control measures, the physician has a primary responsibility for evaluating potential lead toxicity in the worker. It is only through a careful and detailed medical and work history, a complete physical examination and appropriate laboratory testing that an accurate assessment can be made. Many of the adverse health effects of lead toxicity are either irreversible or only partially reversible and therefore early detection of disease is very important.

This document outlines the medical monitoring program as defined by the occupational safety and health standard for inorganic lead. It reviews the adverse health effects of lead poisoning and describes the important elements of the history and physical examinations as they relate to these adverse effects. Finally, the appropriate laboratory testing for evaluating lead exposure and toxicity is presented.

It is hoped that this review and discussion will give the physician a better understanding of the OSHA standard with the ultimate goal of protecting the health and well-being of the worker exposed to lead under his or her care.

APPENDIX D TO § 1910.1025—QUALITATIVE FIT TEST PROTOCOLS

This appendix specifies the only allowable qualitative fit test protocols permissible for compliance with paragraph (f)(3)(ii).

I. ISOAMYL ACETATE PROTOCOL

- A. Odor threshold screening.
 1. Three 1-liter glass jars with metal lids (e.g. Mason or Bell jars) are required.
 2. Odor-free water (e.g. distilled or spring water) at approximately 25°C shall be used for the solutions.
 3. The isoamyl acetate (IAA) (also known as isopentyl acetate) stock solution is prepared by adding 1 cc of pure IAA to 800 cc of odor free water in a 1-liter jar and shaking for 30 seconds. This solution shall be prepared new at least weekly.
 4. The screening test shall be conducted in a room separate from the room used for actual fit testing. The two rooms shall be well ventilated but may not be connected to the same recirculating ventilation system.
 5. The odor test solution is prepared in a second jar by placing .4 cc of the stock solution into 500 cc of odor free water using a clean dropper or pipette. Shake for 30 seconds and allow to stand for two to three minutes so that the IAA concentration above the liquid may reach equilibrium. This solution may be used for only one day.
 6. A test blank is prepared in a third jar by adding 500 cc of odor free water.
 7. The odor test and test blank jars shall be labelled 1 and 2 for jar identification. If the labels are put on the lids they can be periodically dried off and switched to avoid people thinking the same jar always has the IAA.
 8. The following instructions shall be typed on a card and placed on the table in front of the two test jars (i.e. 1 and 2):
 "The purpose of this test is to determine if you can smell banana oil at a low concentration. The two bottles in front of you contain water. One of these bottles also contains a small amount of banana oil. Be sure the covers are on tight, then shake each bottle for two seconds. Unscrew the lid of each bottle, one at a time, and sniff at the mouth of the bottle. Indicate to the test conductor which bottle contains banana oil."
 9. The mixtures used in the IAA odor detection test shall be prepared in an area separate from where the test is performed, in order to prevent olfactory fatigue in the subject.
 10. If the test subject is unable to correctly identify the jar containing the odor test solution, the IAA QLFT may not be used.
 11. If the test subject correctly identifies the jar containing the odor test solution he

Occupational Safety and Health

may proceed to respirator selector testing.

B. Respirator selection.

1. The test subject shall be allowed to select the most comfortable respirator from a large array of various sizes and manufacturers that includes at least three elastomeric half facepieces and one least two manufacturers.
2. The selection process shall be conducted in a room separate from the chamber to prevent odor fatigue. In the selection process, the test subject shall be shown how to put on a respirator, how to strap tension and how to assess a "comfortable" respirator. A mirror shall be available to assist the subject in evaluating fit and positioning of the respirator. The subject may not constitute his formal training respirator use, only a review.
3. The test subject should understand that he is being asked to select the respirator which provides the most comfortable fit for him. Each respirator represents a different size and shape and, if fit properly, will provide adequate protection.
4. The test subject holds each facepiece to his face and eliminates those which obviously not giving a comfortable fit. Initially, selection will begin with a half mask and if a fit cannot be found here, the subject will be asked to go to the full face respirators. (A small percentage of users will not be able to wear any half-mask.)
5. The more comfortable facepieces are recorded; the most comfortable mask is donned and worn at least five minutes. Assistance in assessing comfort can be given by discussing the points #6 below. If the test subject is not satisfied with using a particular respirator, he shall be directed to don the mask several times and to adjust the straps each time, so he becomes adept at setting proper tension on the straps.
6. Assessment of comfort shall include viewing the following points with the subject:
 - Chin properly placed.
 - Positioning of mask on nose.
 - Strap tension.
 - Fit across nose bridge.
 - Room for safety glasses.
 - Distance from nose to chin.
 - Room to talk.
 - Tendency to slip.
 - Cheeks filled out.
 - Self-observation in mirror.
 - Adequate time for assessment.
7. The test subject shall conduct the conventional negative and positive-pressure checks (e.g. see ANSI Z88.2-1980). By conducting the negative or positive-pressure checks, the subject shall be to "seat" his mask by rapidly moving the

Rainbow Passage

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond reach, his friends say he is looking for the pot of gold at the end of the rainbow.

vi. Normal breathing.

5. Each test subject shall wear his respirator for at least 10 minutes before starting the fit test.

6. Upon entering the test chamber, the test subject shall be given a 6 inch by 5 inch piece of paper towel or other porous absorbent single ply material, folded in half and wetted with three-quarters of one cc of pure IAA. The test subject shall hang the wet towel on the hook at the top of the chamber.

7. Allow two minutes for the IAA test concentration to be reached before starting the fit-test exercises. This would be an appropriate time to talk with the test subject, to explain the fit test, the importance of his cooperation, the purpose for the head exercises, or to demonstrate some of the exercises.

8. Each exercise described in No. 4 above shall be performed for at least one minute.

9. If at any time during the test, the subject detects the banana-like odor of IAA, he shall quickly exit from the test chamber and leave the test area to avoid olfactory fatigue.

10. Upon returning to the selection room, the subject shall remove the respirator, repeat the odor sensitivity test, select and put on another respirator, return to the test chamber, etc. The process continues until a respirator that fits well has been found. Should the odor sensitivity test be failed, the subject shall wait about 5 minutes before retesting. Odor sensitivity will usually have returned by this time.

11. If a person cannot be fitted with the selection of half-mask respirators, include full facepiece models in the selection process. When a respirator is found that passes the test, its efficiency shall be demonstrated for the subject by having him break the face seal and take a breath before exiting the chamber.

12. When the test subject leaves the chamber he shall remove the saturated towel, returning it to the test conductor. To keep the area from becoming contaminated, the used towels shall be kept in a self-sealing bag. There is no significant IAA concentration buildup in the test chamber from subsequent tests.

13. Persons who have successfully passed this fit test may be assigned the use of the tested respirator in atmospheres with up to 10 times the PEL of airborne lead. In other words this IAA protocol may be used to assign a protection factor no higher than 10.

II. SACCHARIN SOLUTION AEROSOL PROTOCOL

A. Taste threshold screening.

1. Threshold screening as well as fit testing employees shall use an enclosure about the head and shoulders that is approximately 12 inches in diameter by 14 inches tall with at least the front portion clear and that allows free movement of the head when a respirator is worn. An enclosure substantially similar to the 3M hood assembly of part # FT 14 and FT 15 combined is adequate.

2. The test enclosure shall have a three-quarter inch hole in front of the test subject's nose and mouth area to accommodate the nebulizer nozzle.

3. The entire screening and testing procedure shall be explained to the test subject prior to the conduct of the screening test.

4. The test subject shall don the test enclosure. For the threshold screening test, he shall breath through his open mouth with tongue extended.

5. Using a DeVilbiss Model 40 Inhalation Medication Nebulizer or equivalent, the test conductor shall spray the threshold check solution into the enclosure. This nebulizer shall be clearly marked to distinguish it from the fit test solution nebulizer.

6. The threshold check solution consists of 0.83 grams of sodium saccharin, USP in water. It can be prepared by putting 1 cc of the test solution (see C8 below) in 100 cc of water.

7. To produce the aerosol, the nebulizer bulb is firmly squeezed so that it collapses completely then released and allowed to fully expand.

8. Ten squeezes are repeated rapidly and then the test subject is asked whether the saccharin can be tasted.

9. If the first response is negative, ten more squeezes are repeated rapidly and the test subject is again asked whether the saccharin is tasted.

10. If the second response is negative ten more squeezes are repeated rapidly and the test subject is again asked whether the saccharin is tasted.

11. The test conductor will take note of the number of squeezes required to elicit a taste response.

12. If the saccharin is not tasted after 30 squeezes (Step 9), the test subject may not perform the saccharin fit test.

13. If a taste response is elicited, the test subject shall be asked to take note of the taste for reference in the fit test.

14. Correct use of the nebulizer that approximately 1 cc of liquid is time in the nebulizer body.

15. The nebulizer shall be thrice rinsed in water, shaken dry, and used at least each morning and afternoon every four hours.

B. Respirator selection.

Respirators shall be selected as in section IB above, except that each respirator shall be equipped with a prefilter cartridge.

C. Fit test.

1. The fit test uses the same enclosure described in B1 and B2 above.

2. Each test subject shall wear his respirator for at least 10 minutes before the fit test.

3. The test subject shall don the respirator while wearing the respirator selection A above. This respirator shall be properly adjusted and equipped with a prefilter cartridge.

4. The test subject may not eat (except plain water), or chew gum minutes before the test.

5. A second DeVilbiss Model 40 Inhalation Medication Nebulizer or equivalent shall be used to spray the fit test solution into the enclosure. This nebulizer shall be clearly marked to distinguish it from the screening solution nebulizer.

6. The fit test solution is prepared by adding 83 grams of sodium saccharin to 100 cc of warm water.

7. As before, the test subject shall breath through the open mouth with tongue extended.

8. The nebulizer is inserted into the front of the enclosure and the fit test solution is sprayed into the enclosure using the same technique as the threshold screening and the number of squeezes required to elicit response in the screening. (See B 11)

9. After generation of the aerosol the test subject shall be instructed to perform the following exercises for one minute each.

i. Normal breathing.

ii. Deep breathing. Be certain breath is deep and regular.

iii. Turning head from side-to-side until movement is complete. Alert the test subject not to bump the respirator on his shoulders. Have the test subject when his head is at either side.

iv. Nodding head up-and-down. Be certain motions are complete. Alert the test subject not to bump the respirator on his head. Have the test subject inhale when in the fully up position.

v. Talking. Talk aloud and slowly for several minutes. The following paragraph is called the Rainbow Passage. Reading this result in a wide range of facial motion and thus be useful to satisfy this

13. Persons who have successfully passed the fit test may be assigned the use of the tested respirator in atmospheres with up to 10 times the PEL of airborne lead. In other words this IAA protocol may be used to assign a protection factor no higher than 10.

SACCHARIN SOLUTION AEROSOL PROTOCOL

Taste threshold screening.

1. Threshold screening as well as fit testing employees shall use an enclosure about the head and shoulders that is approximately 22 inches in diameter by 14 inches tall with at least the front portion clear and that allows free movement of the head when a respirator is worn. An enclosure substantially similar to the 3M hood assembly part # FT 14 and FT 15 combined is adequate.

2. The test enclosure shall have a three-quarter inch hole in front of the test subject's nose and mouth area to accommodate the nebulizer nozzle.

The entire screening and testing procedure shall be explained to the test subject prior to the conduct of the screening test.

The test subject shall don the test enclosure. For the threshold screening test, he shall breathe through his open mouth with tongue extended.

3. Using a DeVilbiss Model 40 Inhalation Medication Nebulizer or equivalent, the test conductor shall spray the threshold check solution into the enclosure. This nebulizer shall be clearly marked to distinguish it from the fit test solution nebulizer.

The threshold check solution consists of 10 grams of sodium saccharin, USP in water. It can be prepared by putting 1 cc of the test solution (see C6 below) in 100 cc of water.

To produce the aerosol, the nebulizer is firmly squeezed so that it collapses completely then released and allowed to fully expand.

4. Ten squeezes are repeated rapidly and the test subject is asked whether the saccharin can be tasted.

5. If the first response is negative, ten more squeezes are repeated rapidly and the test subject is again asked whether the saccharin is tasted.

6. If the second response is negative ten more squeezes are repeated rapidly and the test subject is again asked whether the saccharin is tasted.

7. The test conductor will take note of the number of squeezes required to elicit a taste response.

8. If the saccharin is not tasted after 30 squeezes (Step 9), the test subject may not perform the saccharin fit test.

9. If a taste response is elicited, the test subject shall be asked to take note of the response for reference in the fit test.

14. Correct use of the nebulizer means that approximately 1 cc of liquid is used at a time in the nebulizer body.

15. The nebulizer shall be thoroughly rinsed in water, shaken dry, and refilled at least each morning and afternoon or at least every four hours.

B. Respirator selection.

Respirators shall be selected as described in section IB above, except that each respirator shall be equipped with a particulate filter cartridge.

C. Fit test.

1. The fit test uses the same enclosure described in B1 and B2 above.

2. Each test subject shall wear his respirator for at least 10 minutes before starting the fit test.

3. The test subject shall don the enclosure while wearing the respirator selected in section A above. This respirator shall be properly adjusted and equipped with a particulate filter cartridge.

4. The test subject may not eat, drink (except plain water), or chew gum for 15 minutes before the test.

5. A second DeVilbiss Model 40 Inhalation Medication Nebulizer or equivalent, is used to spray the fit test solution into the enclosure. This nebulizer shall be clearly marked to distinguish it from the screening test solution nebulizer.

6. The fit test solution is prepared by adding 83 grams of sodium saccharin to 100 cc of warm water.

7. As before, the test subject shall breathe through the open mouth with tongue extended.

8. The nebulizer is inserted into the hole in the front of the enclosure and the fit test solution is sprayed into the enclosure using the same technique as for the taste threshold screening and the same number of squeezes required to elicit a taste response in the screening. (See B 10 above).

9. After generation of the aerosol the test subject shall be instructed to perform the following exercises for one minute each.

i. Normal breathing.

ii. Deep breathing. Be certain breaths are deep and regular.

iii. Turning head from side-to-side. Be certain movement is complete. Alert the test subject not to bump the respirator on the shoulders. Have the test subject inhale when his head is at either side.

iv. Nodding head up-and-down. Be certain motions are complete. Alert the test subject not to bump the respirator on the chest. Have the test subject inhale when his head is in the fully up position.

v. Talking. Talk aloud and slowly for several minutes. The following paragraph is called the Rainbow Passage. Reading it will result in a wide range of facial movements, and thus be useful to satisfy this require-

ment. Alternative passages which serve the same purpose may also be used.

Rainbow Passage

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond his reach, his friends say he is looking for the pot of gold at the end of the rainbow.

10. Every 30 seconds, the aerosol concentration shall be replenished using one-half the number of squeezes as initially (C8).

11. The test subject shall so indicate to the test conductor if at any time during the fit test the taste of saccharin is detected.

12. If the saccharin is detected the fit is deemed unsatisfactory and a different respirator shall be tried.

13. Successful completion of the test protocol shall allow the use of the tested respirator in contaminated atmospheres up to 10 times the PEL. In other words this protocol may be used assign protection factors no higher than ten.

III. IRRITANT FUME PROTOCOL

A. Respirator selection.

Respirators shall be selected as described in section IB above, except that each respirator shall be equipped with high efficiency cartridges.

B. Fit test.

1. The test subject shall be allowed to smell a weak concentration of the irritant smoke to familiarize him with the characteristic odor of each.

2. The test subject shall properly don the respirator selected as above, and wear it for at least 10 minutes before starting the fit test.

3. The test conductor shall review this protocol with the test subject before testing.

4. The test subject shall perform the conventional positive pressure and negative pressure fit checks. Failure of either check shall be cause to select an alternate respirator.

5. Break both ends of a ventilation smoke tube containing stannic oxychloride, such as the MSA part No. 5645, or equivalent. Attach a short length of tubing to one end of the smoke tube. Attach the other end of the smoke tube to a low pressure air pump set to deliver 200 milliliters per minute.

6. Advise the test subject that the smoke can be irritating to the eyes and instruct him to keep his eyes closed while the test is performed.

7. The test conductor shall direct the stream of irritant smoke from the tube towards the face/ear area of the test subject. He shall begin at least 12 inches from the facepiece and gradually move to within one inch, moving around the whole perimeter of the mask.

8. The following exercises shall be performed while the respirator seal is being challenged by the smoke. Each shall be performed for one minute.

i. Normal breathing.

ii. Deep breathing. Be certain breaths are deep and regular.

iii. Turning head from side-to-side. Be certain movement is complete. Alert the test subject not to bump the respirator on the shoulders. Have test subject inhale when his head is at either side.

iv. Nodding head up-and-down. Be certain motions are complete. Alert the test subject not to bump the respirator on the chest. Have the test subject inhale when his head is in the fully up position.

v. Talking—slowly and distinctly, count backwards from 100.

vi. Normal breathing.

9. If the irritant smoke produces an involuntary reaction (cough) by the test subject, the test conductor shall stop the test. In this case the tested respirator is rejected and another respirator shall be selected.

10. Each test subject passing the smoke test without evidence of a response shall be given a sensitivity check of the smoke from the same tube to determine whether he reacts to the smoke. Failure to evoke a response shall void the fit test.

11. Steps B4, B7, B8 of this protocol shall be performed in a location with exhaust ventilation sufficient to prevent general contamination of the testing area by the irritant smoke.

12. Respirators successfully tested by the protocol may be used in contaminated atmospheres up to ten times the PEL. In other words this protocol may be used to assign protection factors not exceeding ten. [43 FR 53007, Nov. 14, 1978]

EDITORIAL NOTE: For FEDERAL REGISTER citations affecting § 1910.1025 see the List of CFR Sections Affected in the Finding Aids section of this volume.

§ 1910.1028 Benzene.

(a) *Scope and application.* (1) This section applies to all occupational exposures to benzene. Chemical Abstracts Service Registry No. 71-43-2, except as provided in paragraphs (a)(2) and (a)(3) of this section.

(2) This section does not apply to:

(i) The storage, transportation, distribution, dispensing, sale or use of gasoline, motor fuels, or other fuels

containing benzene subsequent to its final discharge from bulk wholesale storage facilities, except that operations where gasoline or motor fuels are dispensed for more than 4 hours per day in an indoor location are covered by this section.

(ii) Loading and unloading operations at bulk wholesale storage facilities which use vapor control systems for all loading and unloading operations, except for the provisions of 29 CFR 1910.1200 as incorporated into this section and the emergency provisions of paragraphs (g) and (i)(4) of this section.

(iii) The storage, transportation, distribution or sale of benzene or liquid mixtures containing more than 0.1 percent benzene in intact containers or in transportation pipelines while sealed in such a manner as to contain benzene vapors or liquid, except for the provisions of 29 CFR 1910.1200 as incorporated into this section and the emergency provisions of paragraphs (g) and (i)(4) of this section.

(iv) Containers and pipelines carrying mixtures with less than 0.1 percent benzene and natural gas processing plants processing gas with less than 0.1 percent benzene.

(v) Work operations where the only exposure to benzene is from liquid mixtures containing 0.5 percent or less of benzene by volume, or the vapors released from such liquids until September 12, 1988; work operations where the only exposure to benzene is from liquid mixtures containing 0.3 percent or less of benzene by volume or the vapors released from such liquids from September 12, 1988, to September 12, 1989; and work operations where the only exposure to benzene is from liquid mixtures containing 0.1 percent or less of benzene by volume or the vapors released from such liquids after September 12, 1989; except that tire building machine operators using solvents with more than 0.1 percent benzene are covered by paragraph (i) of this section.

(vi) Oil and gas drilling, production and servicing operations.

(vii) Coke oven batteries.

(3) The cleaning and repair of barges and tankers which have contained benzene are excluded from paragraph

(f) methods of compliance, paragraph (e)(1) exposure monitoring and paragraph (e)(6) accuracy of monitoring. Engineering and work controls shall be used to keep exposures below 10 ppm unless it is to be not feasible.

(b) *Definitions.*

Action level means an airborne concentration of benzene of 0.5 ppm calculated as an 8-hour time-weighted average.

Assistant Secretary means Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

Authorized person means an individual specifically authorized by the employer whose duties require the person to enter a regulated area, or any person entering such an area as a representative of employees for the purpose of exercising the right to serve monitoring and measuring duties under paragraph (i) of this section, or any other person authorized by the Act or regulations issued by the Act.

Benzene (C₆H₆) (CAS Registry No. 71-43-2) means liquefied or solid benzene. It includes benzene in liquid mixtures and the vapors released by these liquids but does not include trace amounts of reacted benzene contained in materials.

Bulk wholesale storage means a bulk terminal or bulk storage where fuel is stored prior to delivery to wholesale customers.

Container means any barrel, can, cylinder, drum, reaction storage tank, or the like, but does not include piping systems.

Day means any part of a calendar day.

Director means the Director of the National Institute for Occupational Safety and Health, U.S. Department of Health and Human Services or designee.

Emergency means any occurrence such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment which or does result in an unexpected or uncontrolled release of benzene.

Employee exposure means exposure to airborne benzene which

Attachment D
Safety Plan Review and Acknowledgement Form

SITE SAFETY PLAN ACKNOWLEDGEMENT FORM

Malaga Road Ash Pile Site/Monroe Township Contaminated Soil Site

By placing my signature below, I certify that I have read the site safety plan, fully understand its requirements and will follow all safety directives set forth by the plan or directed by the EPA OSC as long as I am present at the site.

[illegible]

ATTACHMENT E

AMENDMENT FOR
SITE-SPECIFIC
HEALTH AND SAFETY PLAN
FOR
REMEDATION RESPONSE FOR REMOVAL OF
CONTAMINATED SOIL AND ASH PILE SITES
MONROE TOWNSHIP, NEW JERSEY

Prepared for:

U.S. Environmental Protection Agency
Region II - Removal Action Branch
Edison, New Jersey

Prepared by:

OHM Remediation Services Corp.
Trenton, New Jersey



Paul A. Lawless, IHIT
Industrial Hygienist

May 9, 1994
OHM Project # 16129 and # 16132

AMENDMENT TO SECTION 1.0

KEY PERSONNEL

The USEPA On-Scene Coordinator (OSC), ERCS Program Manager (PM), Response Manager (RM), Certified Industrial Hygienist (CIH), Site Safety Officer (SSO) and TAT representatives share responsibilities for formulating and enforcing health and safety requirements, and implementing the HASP.

1.1 CERTIFIED INDUSTRIAL HYGIENIST

The CIH should be responsible for the contents of the HASP and should ensure that the HASP complies with all federal, state and local health and safety requirements. If necessary, the CIH can modify specific aspect of the HASP to adjust for on-site changes that affect safety. The CIH will coordinate with the SSO on all modifications to the HASP and will be available for consultation when required. The CIH will not necessarily be on site during OHM activities.

1.2 SITE SAFETY OFFICER

The SSO has responsibility for administering the HASP relative to site activities, and will be in the field full-time while site activities are in progress. The SSO's primary operational responsibilities will be monitoring, including personal and environmental monitoring, personal protective equipment maintenance, and assignment of protection levels. The SSO will be the main contact in any on-site emergency situation. The SSO will direct all field activities involved with safety and be responsible for stopping work when unacceptable health or safety risk exists. The SSO is responsible for assuring that all on-site personnel understand and comply with all safety requirements.

1.3 PROGRAM MANAGER (ERCS)

The PM has the overall responsibility for the project and to assure that the goals of the emergency response action are attained in a manner consistent with the HASP requirements. The PM will coordinate with the RM and the SSO to assure that the goals are completed in a manner consistent with the HASP.

1.4 RESPONSE MANAGER (ERCS)

The RM is responsible for field implementation of the HASP and Site Emergency Response and Contingency Plan. The RM is responsible for field implementation of the HASP. The RM will establish and ensure compliance with site control areas and procedures and coordinate these supervisory responsibilities with the site SSO.

1.5 EMPLOYEE SAFETY RESPONSIBILITY

Each employee is responsible for personal safety as well as the safety of others in the area. The employee will use all equipment provided in a safe and responsible manner as directed by the RM. All OHM personnel will follow the policies set forth in OHM's Employee Safety Guide and the OHM Health and Safety Procedures.

1.6 OSHA RECORDS

Required records including the OSHA 200 log are maintained at the OHM Divisional offices.

1.7 KEY SAFETY PERSONNEL

The following individuals share responsibility for health and safety at the site.

USEPA On-Scene Coordinator
(OSC)

James D. Harkay
USEPA Region II
2890 Woodbridge Avenue
Edison, NJ 08837
908-321-6614

ERCS Response Manager

Todd King
609-421-7546 (pager)

TAT Representatives

Eric Wilson
~~Bratt~~ Booz
Roy F. Weston, Inc.
1090 King Georges Post Road
Suite 201
Edison, NJ 08837
908-225-6116

ERCS Site Safety Officer

ERCS Program Manager

Tom O' Hara
609-588-6395 (office)
800-759-7243 Pin # 204-0535 (pager)

ERCS Health and Safety
Director

Kevin McMahon, M.S., CIH
609-588-6375 (office)
609-421-7523 (pager)

ERCS Vice President, Health
and Safety

Fred Halvorsen, Ph.D., PE, CIH
800-231-7031

JOB HAZARD ANALYSIS

2.1 CHEMICAL HAZARDS

2.1 CHEMICAL HAZARDS			
CHEMICAL	EXPOSURE ROUTES	PEL/TLV	HEALTH HAZARDS/ PHYSICAL HAZARDS
Lead	Inhalation, ingestion	0.050 mg/m3	Weakness, insomnia; loss of appetite, loss of weight, abdominal pain; anemia; tremors; weakness of wrists/ ankles; kidney damage; low blood pressure
			Reacts with strong oxidizers
Chromium	Inhalation, ingestion	1.0 mg/m3	Scarring of lung tissue
			Reacts with strong oxidizers, alkalis
Mercury	Inhalation, skin	0.05 mg/m3	Cough, chest pain, shortness of breath; tremor, insomnia, irritability, headache, weakness, stomach pain, loss of appetite; kidney damage
			Reacts with acetylene, ammonia, chlorine dioxide metals
Arsenic	Skin, Eye, Inhalation, Ingestion	0.2 mg/m3	A powerful allergen, arsenic will cause burning swelling, and redness in the eyes, nose, throat, and skin A human carcinogen; Long term exposure can cause liver, kidney, and blood damage
			A fire hazard in the form of dust or contact with oxidizers
Copper	Inhalation, ingestion	1.0 mg/m3	A mucous membrane, respiratory irritant; conjunctivitis; nausea, vomiting, abdominal pain
			Reacts with acids and oxidizers, copper reactions may release flammable gas (hydrogen)

JOB HAZARD ANALYSIS

May 9, 1994

Revision No. 0

2.1 CHEMICAL HAZARDS			
CHEMICAL	EXPOSURE ROUTES	PEL/TLV	HEALTH HAZARDS/ PHYSICAL HAZARDS
Cadmium	Inhalation, ingestion	0.05 mg/m3	A probable carcinogen; skin, eye, respiratory irritation; mild flu and fever symptoms (metal fume fever); pneumonitis, pulmonary edema
			Reacts violently with ammonium nitrate; finely divided cadmium metal can become pyrophoric; avoid heat, flame, causes cadmium fume formation
Thallium	Skin, eye, inhalation, ingestion	0.1 mg/m3Skin	Nausea, vomiting, tingling or pain in extremities, weakness, coma, convulsions; affects eyes, CNS, kidneys, liver, lungs, GI tract; treat ingestion as a poisoning emergency
			Reacts violently with fluorine; forms highly toxic thallium oxide in contact with air, forms rapidly during fires; highly flammable metallic dust
Zinc	Inhalation, ingestion	10.0 mg/m3	A skin, eye, and respiratory irritant; a nuisance dust; health effects primarily from fume inhalation, metal fume fever; chromates of zinc are human carcinogens
			Zinc salts are incompatible with reactive cyanides and sulfides
Barium	Inhalation, ingestion	0.5 mg/m3	Insoluble salts are skin, eye, and respiratory irritants; a nuisance dust; water soluble compounds are highly toxic by ingestion; abdominal pain, vomiting, diarrhea, convulsions, muscular spasms, internal hemorrhage
			Insoluble compounds are largely non-reactive; thermal decomposition can release toxic gases
Silver	Skin, eye, inhalation, ingestion	0.01 mg/m3	A corrosive irritant to skin, eyes and mucous membranes; nausea, metallic taste, abdominal pain; ingestion can be fatal
			A powerful oxidizer; reacts with metals, petroleum hydrocarbons, alkali liquids and solids, halogens and some acids

JOB HAZARD ANALYSIS

May 9, 1994

Revision No. 0

2.1 CHEMICAL HAZARDS			
CHEMICAL	EXPOSURE ROUTES	PEL/TLV	HEALTH HAZARDS/ PHYSICAL HAZARDS
Nickel	Skin, eye, inhalation, ingestion	0.05 mg/m3	An upper respiratory irritant; skin eruptions and allergic dermatitis; nausea, vomiting, giddiness from ingestion; A confirmed human carcinogen
			Nickel salts can react with potassium, strong oxidizers, or mineral acids to form toxic, flammable or explosive gases
Antimony	Skin, eye, inhalation, ingestion	0.5 mg/m3	An irritant of the eyes, skin, and mucous membranes; dermatitis resembling chicken-pox rash; ingestion, extreme nausea, vomiting, diarrhea, slow pulse, shallow breathing, can be fatal; inhalation, chemical pneumonia, lung, liver, heart, kidney complications
			Reacts violently with oxidizers; emits highly toxic stibine gas in contact with acids; reactivity is further increased when heated
Selenium	Skin, eye, inhalation, ingestion	0.2 mg/m3	A severe corrosive irritant of eyes, skin, upper respiratory tract; inhalation produces chemical pneumonia; garlic odor of breath, fatigue, irritability, metallic taste; allergic eye reaction with red, puffy eyelids
			Reacts violently with oxidizers and light metals; thermal decomposition emits highly toxic gases
Dioxin	inhalation, ingestion	N/E	A pesticide/herbicide bi-product; most dioxins are possible/probable human carcinogens; can form as a result of combustion of chlorinated hydrocarbons; symptoms of exposure may not be apparent; dioxins tend to accumulate in living tissue
			dioxins emit toxic chlorine gas during thermal decomposition

Personnel will be removed from the work site and placed under observation immediately if the following symptoms occur:

- Dizziness or stupor
- Nausea, headaches, or cramps
- Irritation of the eyes, nose, or throat
- Euphoria
- Chest pains and coughing
- Rashes or burns

2.2 PHYSICAL HAZARDS

To minimize physical hazards, OHM has developed standard safety protocols which will be followed at all times. Failure to follow safety protocols will result in expulsion of a crew member from the site.

All OHM personnel are familiar with the field activities which will be conducted at the site. They are trained to work safely under various field conditions. The SS and SSO will observe the general work practices of each crew member and equipment operator, and enforce safe procedures to minimize physical hazards. Also, hard hats, safety glasses, and steel-toe safety boots are required in all areas of the site.

2.3 ENVIRONMENTAL HAZARDS

Environmental factors such as weather, wild animals, insects, and irritant plants always pose a hazard when performing outdoor tasks. The SSO and SS will make every effort to alleviate these hazards should they arise.

2.3.1 Heat Stress

The combination of warm ambient temperature and protective clothing increases the potential for heat stress. In particular:

- Heat rash
- Heat cramps
- Heat exhaustion
- Heat stroke

Heat stress is covered in detail during 40-hour OSHA 29 CFR 1910.120 training. In addition, this information is discussed during safety meetings before each workday. Workers are encouraged to increase consumption of water and electrolyte-containing beverages such as Gatorade.

At a minimum, workers will break every 2 hours for 10- to 15-minute rest periods. In addition, workers are advised to take rests whenever they feel any adverse effects that may be heat-related. The SSO and SS will monitor rest breaks and increase frequency as required to prevent symptoms.

A work/rest schedule can be calculated based on heat stress monitoring results. Monitoring consists of taking the radial pulse of a worker for 30 seconds immediately after exiting the work area. The frequency of monitoring is provided below.

<u>Weight (in lbs.)</u>	<u>2.0% of your weight</u>	<u>5.0% of your weight</u>
125	2.5	6.25
130	2.6	6.5
135	2.7	6.75
140	2.8	7.0
145	2.9	7.25
150	3.0	7.5
155	3.1	7.75
160	3.2	8.0
165	3.3	8.25
170	3.4	8.5
175	3.5	8.75
180	3.6	9.0
185	3.7	9.25
190	3.8	9.5
195	3.9	9.75
200	4.0	10.0
205	4.1	10.25
210	4.2	10.5
215	4.3	10.75
220	4.4	11.0
225	4.5	11.25
230	4.6	11.5
235	4.7	11.75
240	4.8	12.0
245	4.9	12.25
250	5.0	12.5

If you lose 2.0% of your body weight, you may begin to experience decreased tolerance to heat stress, characterized by increased heart rate and body temperature and decreased work capacity.

If you lose 5.0% of your body weight, you may begin to experience serious symptoms of heat-related illness including collapse.

Source: Criteria for a Recommended Standard...Occupational Exposure to Hot Environments, NIOSH, 1986, Cincinnati.

- Pulse - 110 BPM exceeds shorten work cycle by $\frac{1}{3}$ →

body Temp. -

AMBIENT TEMPERATURE	LEVEL D PPE	LEVEL C PPE/ MODIFIED LEVEL D
90° F or above	After 45 minutes of work	After 15 minutes of work
87.5 F-90 F	After 60 minutes of work	After 30 minutes of work
82.5-87.5 F	After 90 minutes of work	After 60 minutes of work
77.5-82.5 F	After 120 minutes of work	After 90 minutes of work
72.5-77.5 F	After 150 minutes of work	After 120 minutes of work

If the heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by 1/3 and keep the rest period the same. If the heart rate still exceeds 110 beats per minute at the next rest period, increase the following rest period by 1/3. The initial rest period should be at least 5 minutes.

Monitoring for heat stress will begin when the ambient temperature reaches or exceeds 70 degrees Fahrenheit, when wearing Level C PPE, or 80 degrees Fahrenheit for site activities performed in Level D.

2.2.3 Biological Hazards

- POISON IVY (Rhus Radicans)

Poison Ivy may be found at the site. It is highly recommended that all personnel entering into an area with poison ivy wear a minimum of a paper tyvek, to avoid skin contact.

Contact with poisonous plants:

Characteristic reactions

The majority of skin reactions following contact with offending plants are allergic in nature and characterized by:

- General symptoms of headache and fever
- Itching
- Redness
- A rash

Some of the most common and most severe allergic reactions result from contact with plants of the poison ivy group, including poison oak and poison sumac. Such plants produce severe rash characterized by redness, blisters, swelling, and intense burning and itching. The victim may develop a high fever and feel very ill. Ordinarily, the rash begins within a few hours after exposure, but may be delayed 24 to 48 hours.

Distinguishing Features of Poison Ivy Group Plants

The most distinctive features of poison ivy and poison oak are their leaves, which are composed of three leaflets each. Both plants have greenish-white flowers and berries that grow in clusters.

First Aid

- a. Remove contaminated clothing; wash all exposed areas thoroughly with soap and water, followed by rubbing alcohol.
- b. Apply calamine or other soothing lotion if rash is mild.
- c. Seek medical advice if a severe reaction occurs, or if there is a known history of previous sensitivity.

• TICKS

Heavily vegetated areas of a site may have ticks. It is highly recommended that all personnel walking through such areas wear a minimum of a paper tyvek and latex boot covers. The ticks will stand out against the light colors. A tick repellent or insect containing DEET is also suggested.

Ticks can transmit several diseases, including Rocky Mountain spotted fever, a disease that occurs in the eastern portion of the United States as well as the western portion, and Lyme disease. Ticks adhere tenaciously to the skin or scalp. There is some evidence that the longer an infected tick remains attached, the greater is the chance that it will transmit disease.

First Aid

- a. Cover the tick with heavy oil (mineral, salad, or machine) to close its breathing pores. The tick may disengage at once; if not, allow oil to remain in place for a half hour. Carefully (slowly and gently) remove the tick with tweezers, taking care that all parts are removed.
- b. With soap and water, thoroughly, but gently, scrub the area from which the tick has been removed, because disease germs may be present on the skin; also wipe the bite area with an antiseptic. Although use of tweezers for the removal of the tick and application of heat to the tick's body often have been attempted, these methods may leave tick parts in the wound or may injure the skin.
- c. If you have been bitten, place the tick in a jar labeled with the date, location of the bite, and the location acquired. If any symptom appears, such as an expanding red rash, contact a physician immediately.

• LYME DISEASE

Lyme disease may cause a number of medical conditions, including arthritis, that can be treated if you recognize the symptoms early and see your doctor. Early signs may include a flu-like illness, an expanding skin rash and joint pain. If left untreated, Lyme disease can cause serious nerve and heart problems as well as a disabling type of arthritis.

You are more likely to spot early signs of Lyme disease rather than see the tick or its bite. This is because the tick is so small (about the size of the head of a common pin or a period on this page and a little larger after they fill with blood), you may miss it or signs of a bite. However, it is also easy to miss the early symptoms of Lyme disease.

In its early stage, Lyme disease may be a mild illness with symptoms like the flu. It can include a stiff neck, chills, fever, sore throat, headache, fatigue, and joint pain. But this flu-like illness is usually out of season, commonly happening between May and October when ticks bite.

Most people develop a large, expanding skin rash around the area of the bite. Some people may get more than one rash. The rash may feel hot to the touch and may be painful. Rashes vary in size, shape, and color, but often look like a red ring with a clear center. The outer edges expand in size. Its easy to miss the rash and the connection between the rash and the tick bite. The rash develops from three days to as long as a month after the tick bite. Almost one third of those with Lyme disease never get the rash.

Joint or muscle pain may be another early sign of Lime disease. These aches and pains may be easy to confuse with the pain that comes from other types of arthritis. However, unlike many other types of arthritis, this pain seems to move or travel from joint to joint.

In later stages, Lyme disease may be confused with other medical problems. These problems can develop months to years after the first tick bite.

Early treatment of Lyme disease symptoms with antibiotics can prevent the more serious medical problems of later stages. If you suspect that you have symptoms of Lime disease, contact your doctor.

Lyme disease can cause problems with the nervous system that look like other diseases. These include symptoms of stiff neck, severe headache, and fatigue usually linked to meningitis. They may also include pain and drooping of the muscles on the face, called Bell's Palsy. Lyme disease can also mimic symptoms of multiple sclerosis or other types of paralysis.

Lyme disease can also cause serious but reversible heart problems, such as irregular heart beat. Finally, Lyme disease can result in a disabling, chronic type of arthritis that most often affects the knees. Treatment is more difficult and less successful in later stages. Researchers think these more serious problems may be linked to how the body's defence or immune system responds to the infection.

2.4 TASK SPECIFIC RISK ASSESSMENT

2.4.1 ACTIVITY HAZARD ANALYSIS FOR SITE PREPARATION		
TASK BREAKDOWN	POTENTIAL HAZARDS	HAZARD CONTROL MEASURES
Clearing/ Grubbing/	Struck By/ Against Heavy Equipment	<ul style="list-style-type: none"> • Use reflective warning vests worn when exposed to vehicular traffic • Avoid equipment swing areas • Make eye contact with operators before approaching equipment • Understand and review hand signals
	Slips, Trips, Falls	<ul style="list-style-type: none"> • Clear, walkways of equipment, tools, vegetation, excavated material, and debris • Mark, identify, or barricade other obstructions
	Handling Heavy Objects	<ul style="list-style-type: none"> • Observe proper lifting techniques • Obey sensible lifting limits • Use mechanical lifting equipment (hand carts, trucks) to move large, awkward loads
	Sharp Objects	<ul style="list-style-type: none"> • Wear cut resistant work gloves when the possibility of lacerations or other injury may be caused by sharp edges or objects • Maintain all hand and power tools in a safe condition • Keep guards in place during use
	Insect/ Snake Bites	<ul style="list-style-type: none"> • Review injury potential and types of snakes with workers • Avoid insect nests areas, likely habitats of snakes outside work areas • Emphasize The Buddy System where such injury potential exists • Use insect repellant, wear PPE to protect against sting/bite injuries
	Contact Dermatitis	<ul style="list-style-type: none"> • Wear PPE to avoid skin contact with contaminated soil, plants, or other skin irritants • Identify and review poisonous plants with workers
	High Noise Levels	<ul style="list-style-type: none"> • Use hearing protection when exposed to excessive noise levels (greater than 85 dBA over an 8-hour work period)
	High Ambient Temperature	<ul style="list-style-type: none"> • Monitor for heat stress in accordance with OHM Health and Safety Procedures Manual

JOB HAZARD ANALYSIS

May 9, 1994

Revision No. 0

2.4.1 ACTIVITY HAZARD ANALYSIS FOR SITE PREPARATION		
TASK BREAKDOWN	POTENTIAL HAZARDS	HAZARD CONTROL MEASURES
Grading	Struck By/ Against Heavy Equipment	<ul style="list-style-type: none">• Use reflective warning vests worn when exposed to vehicular traffic• Avoid equipment swing areas• Make eye contact with operators before approaching equipment• Understand and review hand signals
	Sharp Objects	<ul style="list-style-type: none">• Wear cut resistant work gloves when the possibility of lacerations or other injury may be caused by sharp edges or objects• Maintain all hand and power tools in a safe condition• Keep guards in place during use
	Insect/ Snake Bites	<ul style="list-style-type: none">• Review injury potential and types of snakes with workers• Avoid insect nests areas, likely habitats of snakes outside work areas• Emphasize The Buddy System where such injury potential exists• Use insect repellant, wear PPE to protect against sting/bite injuries.
	Contact Dermatitis	<ul style="list-style-type: none">• Wear PPE to avoid skin contact with contaminated soil, plants, or other skin irritants• Identify and review poisonous plants with workers
	High Noise Levels	<ul style="list-style-type: none">• Use hearing protection when exposed to excessive noise levels (greater than 85 dBA over an 8-hour work period)
	High Ambient Temperature	<ul style="list-style-type: none">• Monitor for heat stress in accordance with OHM Health and Safety Procedures Manual
Equipment/ Facility Set-up	Slips, Trips, Falls	<ul style="list-style-type: none">• Clear walkways work areas of equipment, tools, vegetation, excavated material and debris• Mark, identify, or barricade other obstructions
	Handling Heavy Objects	<ul style="list-style-type: none">• Observe proper lifting techniques• Obey sensible lifting limits• Use mechanical lifting equipment (hand carts, trucks) to move large, awkward loads

JOB HAZARD ANALYSIS

May 9, 1994

Revision No. 0

2.4.1 ACTIVITY HAZARD ANALYSIS FOR SITE PREPARATION		
TASK BREAKDOWN	POTENTIAL HAZARDS	HAZARD CONTROL MEASURES
Equipment/ Facility Set-up (Continued)	Sharp Objects	<ul style="list-style-type: none">• Wear cut resistant work gloves when the possibility of lacerations or other injury may be caused by sharp edges or objects• Maintain all hand and power tools in a safe condition• Keep guards in place during use
	High Noise Levels	<ul style="list-style-type: none">• Use hearing protection when exposed to excessive noise levels (greater than 85 dBA over an 8-hour work period)
	High/Low Ambient Temperature	<ul style="list-style-type: none">• Monitor for Heat/Cold stress in accordance with OHM Health and Safety Procedures Manual

2.4.2 ACTIVITY HAZARD ANALYSIS FOR DEBRIS STAGING AND REMOVAL		
TASK BREAKDOWN	POTENTIAL HAZARDS	HAZARD CONTROL MEASURES
Debris Removal, Staging	Struck by, Against Debris, Protruding Objects, Splashes	<ul style="list-style-type: none">• Restrict entry to the work area to authorized personnel only• Wear hard hats, face shields, and steel-toe safety boots• Place adequate, safe lighting inside storage trailers• Position lighting for specific tasks
	Slips, Trips, Falls	<ul style="list-style-type: none">• Clear walkways, work areas of equipment, tools, and debris materials• Mark, identify, or barricade other obstructions
	Handling Heavy Objects	<ul style="list-style-type: none">• Observe proper lifting techniques• Obey sensible lifting limits (60 lb. maximum per person manual lifting)• Use mechanical lifting equipment (hand carts, trucks) to move large, awkward loads

2.4.2 ACTIVITY HAZARD ANALYSIS FOR DEBRIS STAGING AND REMOVAL		
TASK BREAKDOWN	POTENTIAL HAZARDS	HAZARD CONTROL MEASURES
Debris Removal, Staging (Continued)	Fire/ Explosion	<ul style="list-style-type: none"> • Eliminate sources of ignition from the work area • Prohibit smoking • Provide ABC (or equivalent) fire extinguishers in all work and flammable storage areas • Store flammable liquids in well ventilated areas • Post "NO SMOKING" signs • Store combustible materials away from flammables • Store all compressed gas cylinders upright, caps in place when not in use • Separate Flammables and Oxidizers by 20 feet minimum
	Sharp Objects	<ul style="list-style-type: none"> • Wear cut resistant work gloves when the possibility of lacerations or other injury may be caused by sharp edges or objects • Maintain all hand and power tools in a safe condition • Keep guards in place during use
	High Noise Levels	<ul style="list-style-type: none"> • Use hearing protection when exposed to excessive noise levels (greater than 85 dBA over an 8-hour work period)
	Inhalation and Contact with Hazardous Substances	<ul style="list-style-type: none"> • Provide workers proper skin, eye and respiratory protection based on the exposure hazards present • Review hazardous properties of site contaminants with workers before operations begin
	Caught In/ Between Moving Parts, Objects	<ul style="list-style-type: none"> • Keep all guards in place during use • De-energize and lock-out machinery before maintenance or service • Maintain all equipment in a safe condition

JOB HAZARD ANALYSIS

May 9, 1994

Revision No. 0

2.4.3 ACTIVITY HAZARD ANALYSIS FOR SOIL EXCAVATION		
TASK BREAKDOWN	POTENTIAL HAZARDS	HAZARD CONTROL MEASURES
Excavation of Soil	Underground Utilities	<ul style="list-style-type: none">• Identify all underground utilities around the excavation site before work commences• Cease work immediately if unknown utility markers are uncovered
	Struck By/ Against Heavy Equipment	<ul style="list-style-type: none">• Use reflective warning vests when exposed to vehicular traffic• Avoid equipment swing areas• Make eye contact with operators before approaching equipment• Understand and review hand signals
	High Noise Levels	<ul style="list-style-type: none">• Use hearing protection when exposed to excessive noise levels (greater than 85 dBA over an 8-hour work period)
	Excavation Wall Collapse	<ul style="list-style-type: none">• Construct diversion ditches or dikes to prevent surface water from entering excavation• Provide good drainage of area adjacent to excavation• Collect ground water/rain water from excavation and dispose of properly• Store excavated material at least 2 feet from the edge of the excavation; prevent excessive loading of the excavation face• Provide sufficient stairs, ladders, or ramps when workers enter excavations over 4 feet in depth• Place ladders no more than 25 feet apart laterally• Treat excavations over 4 feet deep as confined spaces• Complete confined space permit entry procedure• Monitor atmosphere for flammable/toxic vapors, and oxygen deficiency• Slope, bench, shore, or sheet excavations over 5 feet deep if worker entry is required• Assign a competent person to decide soil classification, proper sloping, the correct shoring, or sheeting• Provide at least two means of exit for personnel working in excavations
	Slips, Trips, Falls	<ul style="list-style-type: none">• Clear walkways, work areas of equipment, vegetation, excavated material, tools, and debris• Mark, identify, or barricade other obstructions

2.4.3 ACTIVITY HAZARD ANALYSIS FOR SOIL EXCAVATION		
TASK BREAKDOWN	POTENTIAL HAZARDS	HAZARD CONTROL MEASURES
Excavation of Soil (Continued)	Handling Heavy Objects	<ul style="list-style-type: none"> • Observe proper lifting techniques • Obey sensible lifting limits • Use mechanical lifting equipment (hand carts, trucks) to move large, awkward loads
	Inhalation and Contact with Hazardous Substances	<ul style="list-style-type: none"> • Provide workers proper skin, eye and respiratory protection based on the exposure hazards present. • Review contaminant chemical MSDSs with workers before operations begin • Dampen soil using light water spray to prevent fugitive dust emissions • Cover stockpiled soil with plastic sheeting to prevent fugitive dust emissions
	High Ambient Temperature	<ul style="list-style-type: none"> • Monitor for heat stress in accordance with OHM Health and Safety Procedures Manual
Backfilling	Slips, Trips, Falls	<ul style="list-style-type: none"> • Clear walkways, work areas of equipment, vegetation, excavated material, tools, and debris • Mark, identify, or barricade other obstructions
	Struck By/ Against Heavy Equipment	<ul style="list-style-type: none"> • Use reflective warning vests worn when exposed to vehicular traffic • Avoid equipment swing areas • Make eye contact with operators before approaching equipment • Understand and review hand signals
	Sharp Objects	<ul style="list-style-type: none"> • Wear cut resistant work gloves when the possibility of lacerations or other injury may be caused by sharp edges or objects • Maintain all hand and power tools in a safe condition • Keep guards in place during use

JOB HAZARD ANALYSIS

May 9, 1994

Revision No. 0

2.4.4 ACTIVITY HAZARD ANALYSIS FOR SOIL SAMPLING		
TASK BREAKDOWN	POTENTIAL HAZARDS	HAZARD CONTROL MEASURES
Soil Sampling	Sharp Objects	<ul style="list-style-type: none">• Wear cut resistant work gloves when the possibility of lacerations or other injury may be caused by sharp edges or objects• Maintain all hand and power tools in a safe condition• Keep guards in place during use
	Handling Heavy Objects	<ul style="list-style-type: none">• Observe proper lifting techniques• Obey sensible lifting limits• Use mechanical lifting equipment (hand carts, trucks) to move large, awkward loads
	Slips, Trips, Falls	<ul style="list-style-type: none">• Clear walkways, work areas of equipment, tools, vegetation, excavated material, and debris• Mark, identify, or barricade other obstructions
	Inhalation and Contact with Hazardous Substances	<ul style="list-style-type: none">• Provide workers proper skin, eye and respiratory protection based on the exposure hazards present• Review contaminant chemical MSDSs with workers before operations begin
	High Ambient Temperature	<ul style="list-style-type: none">• Monitor for Heat Stress in accordance with OHM Health and Safety Procedures Manual

SECTION 3.0 PROTECTIVE EQUIPMENT

This section addresses the various levels of personal protective equipment (PPE) which are or may be required at this job site. OHM personnel are trained in the use of all PPE utilized.

3.1 ANTICIPATED PROTECTION LEVELS

TASK	PROTECTION LEVEL	COMMENTS/MODIFICATIONS
Site Preparation	Level D	Cotton gloves, safety glasses, coveralls taped at ankles, work boots
Debris Removal	Level C/D	Down grade to Level D if dust monitoring is below "action levels"; cotton/leather gloves, safety eyewear, coveralls taped at ankles, work boots, PVC rain gear if required
Soil/Ash Sampling	Level C/D	Cotton/leather gloves, safety eyewear, coveralls taped at ankles, work boots, PVC rain gear if required
CRZ Workers	Level D	
SZ Workers	Level D	

3.2 PROTECTION LEVEL DESCRIPTIONS

This sections lists the minimum requirements for each protection level. Modification to these requirements will be noted above.

3.2.1 Level D

Level D consists of the following:

- Safety glasses with side shields
- Hard hat
- Steel-toed work boots
- Work clothing as prescribed by weather

3.2.2 Modified Level D

Modified Level D consists of the following:

- Safety glasses with side shields
- Hard hat
- Steel-toed work boots
- Neoprene, latex or PVC overboots
- Outer nitrile, neoprene, or PVC gloves over latex sample gloves
- Face shield (when projectiles or splashes pose a hazard)
- Tyvek coverall, PVC rain suits when required

3.2.3 Level C

Level C consists of the following:

- Full-face, air-purifying respirator with GMC-H cartridges
- Hooded Tyvek coveralls PVC rain gear
- Hard hat
- Steel-toed work boots
- Neoprene, latex or PVC overboots
- Nitrile, neoprene, or PVC gloves over latex sample gloves
- Face shield (when projectiles or splashes pose a hazard)

3.2.4 Level B

Level B protection consists of the items required for Level C protection with the exception that an air-supplied respirator is used in place of the air-purifying respirator.

3.2.5 Level A

Level A protection consists of the items required for Level B protection with the addition of a fully-encapsulating, vapor-proof suit capable of maintaining positive pressure.

3.3 SUPPLIED-AIR RESPIRATORS

If air monitoring shows that Level B protection is needed, OHM personnel will wear Survivair 9881-02 Hippack Airline respirators with 5-minute egress bottles. Personnel requiring Level "B" protection and high mobility will wear Survivair Mark 2 SCBA units.

3.4 BREATHING-AIR QUALITY

Code of Federal Regulations 29 CFR 1910.134 states breathing air will meet the requirement of the specification for Grade D breathing air as described in the ANSI/CGA Specification G-7.1-1989. OHM requires a certificate of analysis from vendors of breathing air in order to show that the air meets this standard.

3.5 AIR-PURIFYING RESPIRATORS

OHM's air-purifying respirators are the MSA "Ultra-Twin" full-face respirators.

3.6 RESPIRATOR CARTRIDGES

The crew members working in Level C will wear respirators equipped with MSA GMC-H air-purifying cartridges, unless otherwise noted. The GMC-H cartridge holds approval for:

- Organic vapors <1,000 ppm
- Chlorine gas <10 ppm
- Hydrogen chloride <50 ppm
- Sulfur dioxide <50 ppm
- Dusts, fumes and mists with a TWA <0.05 mg/m³
- Asbestos-containing dusts and mists
- Radon daughters
- Radionuclides
- Pesticides

3.7 CARTRIDGE CHANGES

All cartridges will be changed a minimum of once daily. However, water saturation of the HEPA filter or dusty conditions may necessitate more frequent changes. Changes will occur when personnel begin to experience increased inhalation resistance or breakthrough of a chemical warning property.

3.8 INSPECTION AND CLEANING

Respirators are checked periodically by a qualified individual and inspected before each use by the wearer. All respirators and associated equipment will be decontaminated and hygienically cleaned after use.

3.9 FIT TESTING

Annual respirator fit tests are required of all personnel wearing negative-pressure respirators. The test will use isoamyl acetate or irritant smoke. The fit test must be for the style and size of the respirator to be used.

3.10 FACIAL HAIR

No personnel who have facial hair which interferes with the respirator's sealing surface will be permitted to wear a respirator and will not be permitted to work in areas requiring respirator use.

3.11 CORRECTIVE LENSES

Normal eyeglasses cannot be worn under full-face respirators because the temple bars interfere with the respirator's sealing surfaces. For workers requiring corrective lenses, special spectacles designed for use with respirators will be provided.

3.12 CONTACT LENSES

Contact lenses will not be worn with any type of respirator.

3.13 MEDICAL CERTIFICATION

Only workers who have been certified by a physician as being physically capable of respirator usage will be issued a respirator. Personnel unable to pass a respiratory fit test or without medical clearance for respirator use will not be permitted to enter or work in areas on site that require respiratory protection. Employees receive a written physicians opinion that they are fit for general hazardous waste operations as per 29 CFR 1910.120(f)(7).

3.14 SITE-SPECIFIC RESPIRATORY PROTECTION PROGRAM

The OHM Respiratory Protection Program complies with 29 CFR 1910.134. The primary objective of respiratory protection is to prevent atmospheric contamination. When engineering measures to control contamination are not feasible, or while they are being implemented, personal respiratory protective devices will be used.

The criteria for determining respirator need are contained in Section 7.0 of this HASP. The GMC-H cartridges will protect employees from the hazardous substances specific to this site. All respirator users are OSHA trained in proper respirator use and maintenance. The SS and SSO will observe workers during respirator use for signs of stress and will monitor air levels of contaminants to ensure that respiratory protection is sufficient. The SS, CIH, and SSO will also evaluate this HASP weekly to determine its continued effectiveness.

All respirators and cartridges used will provide adequate protection against the hazards for which they were designed in accordance with applicable standards. All persons assigned to use respirators will have medical clearance to do so.